AR TARGET SHEET

The following document was too large to scan as one unit, therefore it has been broken down into sections.

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SECTION 1 **OF** 2

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200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

For External Review

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EXECUTIVE SUMMARY

The 200 Areas Remedial Investigation/Feasibility Study Implementation Plan addresses approximately 700 soil waste sites (and associated structures such as pipelines) resulting from the discharge of liquids and solids from processing facilities to the ground (e.g., ponds, ditches, cribs, burial grounds) in the 200 Areas and assigned to the Environmental Restoration Program. This Plan does not address the waste storage tank farms located in the 200 Areas (or the waste constituents in the vadose zone resulting from their leakage), other waste management programs, decontamination and decommissioning of facilities or buildings, and previously contaminated groundwater. Individual sites within the 200 Areas fall under the auspices of different regulatory agencies and drivers (e.g., *Resource Conservation and Recovery Act of 1976* [RCRA] Past Practice Sites); RCRA treatment, storage and/or disposal units are regulated by the Washington State Department of Ecology, and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) sites are regulated by the U.S. Environmental Protection Agency. The U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology teamed to establish a streamlined approach resulting in a mutual commitment to define and implement a common regulatory, characterization, documentation, and communication strategy which is described in this Implementation Plan.

The Implementation Plan outlines the framework for implementing assessment activities in the 200 Areas to ensure consistency in documentation, level of characterization, and decision making. The Implementation Plan also consolidates background information and other typical work plan materials, to serve as a single referenceable source for this type of information. This Implementation Plan does not provide detailed information about the assessment of individual waste sites or groups. Site-specific data needs, data quality objectives (DQOs), data collection programs, and associated assessment tasks and schedules will be defined in subsequent group-specific (i.e., operable unit-specific) work plans.

A common regulatory framework is established that integrates the RCRA, CERCLA, Federal Facility Regulations, and *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology, et al., 1996) requirements into one standard approach for 200 Areas cleanup activities. A description of the programmatic and regulatory requirements of the RCRA and CERCLA programs is provided for the public and stakeholders who are unfamiliar with the two programs. Special emphasis is given to Hanford-specific application of RCRA and CERCLA as specified in the Tri-Party Agreement, local policy and programmatic requirements, and the basis for integrating these requirements for implementation in the 200 Areas. The CERCLA process will be used as the basis for assessment and remediation activities in the 200 Areas, with modification as needed to concurrently satisfy requirements specific to RCRA corrective action for RCRA Past Practice sites and RCRA closure of treatment, storage, and/or disposal units. This integration process for the two regulatory programs is a modification and advancement over that which has been applied in the 100 and 300 Areas that incorporates improvements that have been identified.

Significant efficiencies are also achieved by reducing the number of operable units from 32 geographical-based groupings to 23 process-based, waste site operable units. Within each of these groups, representative sites will be selected, treatment, storage, and/or disposal units will be included, and the analogous site approach used to obtain characterization information. The grouping of waste sites and selection of candidate representative sites was the first step in developing a consistent characterization strategy that applies the analogous site approach used previously in the 100 and 300 Areas. These groupings can be used to focus the characterization effort on a limited number of specific waste sites that represent the group. The representative site data can then be used to make remedial action decisions for all sites within a group. Sampling of individual waste sites is expected to be required before remedial design to verify the applicability of the representative waste site conceptual model, to confirm that remedial action decisions are appropriate, and to provide data needed to design the remedy. Sampling may also be performed during or after remedial design at non-representative waste sites to verify the proper group placement. The use of the analogous site approach is critical due to the large number of waste sites that exist in the 200 Areas. Field analytical data would ultimately be required at all waste sites, but the collection of this confirmatory data will coincide with the commencement of remedial design activities. Following remediation, verification sampling will also be performed to confirm that cleanup goals have been achieved.

The Implementation Plan also streamlines work plans that are required for each waste site group by consolidating background information and providing a single referenceable source for this information. This allows the information in the group-specific work plans to focus on waste group or waste site-specific information. The background information includes an overview of the 200 Area facilities and processes, their operational history, contaminant migration concepts, and a list of contaminants of concern. It also documents and evaluates existing information to develop a site description and conceptual model of expected site conditions and potential exposure pathways. With this conceptual understanding, preliminary potential applicable or relevant and appropriate requirements, preliminary remedial action objectives, and remedial action alternatives are identified. The alternatives are broadly defined but represent potential alternatives that may be implemented at the site. The identification of potential alternatives helps ensure data needed to fully evaluate the alternatives are collected during the remedial investigation. The type and quality of data are defined through the DQOs and form the basis for the data collection program.

The strategy for implementation of the DQO process and definition of characterization requirements is critical. Flexibility is needed in these activities to account for the differences in site-specific waste site groupings. The Implementation Plan contains a summary of the group-specific work plan process to establish DQOs, followed by a description of the analogous site approach to characterization and a description of characterization techniques that have been used at the Hanford Site.

The Implementation Plan also specifies project management activities, and includes a project schedule. Appendices provide supporting information that is applicable to all waste site groups in the 200 Areas. These sections include the general elements of quality assurance, health and safety, data management, and remedial action technologies that may be referenced and/or expanded upon in future characterization work plans. These appendices provide a foundation to ensure that future work plans are focused on the group-specific details and not the 200 Areas-wide discussions and requirements.

This 200 Areas strategy recognizes the interrelationships between the various activities in the area and the need to integrate with other Environmental Restoration and Hanford project/programs. The plan describes the approach to interfacing with other programs and agencies, the integrated schedule of activities that addresses both RCRA and CERCLA program requirements, and the public participation process.

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ACRONYMS

AAMS	aggregate area management study
AEC	Atomic Energy Commission
ACL	alternative concentration level
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BFMS	Baseline Funds Management System
BHI	Bechtel Hanford, Inc.
CAMU	Corrective Action Management Unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMI	corrective measures implementation
CMS	corrective measure study
COPC	contaminants of potential concern
CPP	CERCLA Past Practice
D&D	decontamination and decommissioning
DCG	derived concentration guide
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DWP	detailed work plan
Ecology	Washington State Department of Ecology
EDTA	ethylenediaminetetraacetic acid
EE/CA	engineering evaluation/cost analysis
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERC	Environmental Restoration Contractor
ERDA	Energy Research and Development Administration
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
FS	feasibility study
GPH	ground penetrating holography
GPR	ground penetrating radar
GWP	group-specific work plan
GW/VZ	groundwater and vadose zone
HASP	health and safety plan
HCRL	Hanford Cultural Resources Laboratory
HEDTA	N-hydroxyethylenediaminetriacetic acid
HEPA	high-efficiency particulate air
HEIS	Hanford Environmental Information System
HPPS	*Hanford Past Practice Strategy*
HRA-EIS	Hanford Remedial Action-Environmental Impact Statements
HSWA	*Hazardous and Solid Waste Amendments of 1984*
HTRW	Hazardous, Toxic, and Radiological Waste
HWMA	*Hazardous Waste Management Act of 1976*
ICP	inductively coupled plasma
LIBS	laser-induced breakdown spectroscopy

LRP	long range plan
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MTCA	*Model Toxics Control Act*
NCP	National Oil And Hazardous Substance Contingency Plan
NEPA	*National Environmental Policy Act*
NESHAP	National Emission Standards For Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPH	normal paraffin hydrocarbons
NRC	U.S. Nuclear Regulatory Commission
NPL	National Priorities List
NRDWL	Nonradioactive Dangerous Waste Landfill
O&M	operation and maintenance
PA	preliminary assessment
PCB	polychlorinated biphenyl
PFP	Plutonium Finishing Plant
PMII	Project Managers Implementation Instructions
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PUREX	plutonium/uranium extraction
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RAO	remedial action objectives
RA	remedial action
RARA	Radiation Area Remedial Action
RAWD	Remedial Action Waste Disposal
RAWP	Remedial Action Work Plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
RD	remedial design
RDR	remedial design report
REDOX	reduction oxidation
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
RLS	radionuclide logging system
ROD	Record of Decision
RPP	RCRA Past Practice
S&M	surveillance and maintenance
SAP	sampling and analysis plan
SDWA	*Safe Drinking Water Act*
SEPA	*State Environmental Policy Act*
SI	site inspection
SWL	solid waste landfill
SWMU	solid waste management unit
TBC	to be considered
TBP	tributyl phosphate
TCE	trichloroethylene
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

Tri-Parties	U.S. Department of Energy, Richland Operations Office, U.S. Environmental Protection Agency, Washington State Department of Ecology
TRU	transuranic
TSCA	*Toxic Substance Control Act*
TSD	treatment, storage, and/or disposal
UNH	uranyl nitrate hexahydrate
UR	Unplanned Release
URP	Uranium Recovery Project
WAC	Washington Administrative Code
WBS	work breakdown structure
WESF	Waste Encapsulation And Storage Facility
WIDS	Waste Inventory Data System
VOC	volatile organic compound

1.0 INTRODUCTION

The Hanford Site, managed by the U.S. Department of Energy (DOE), encompasses approximately 1,450 km^2 (560 mi^2) in the Columbia Basin of south-central Washington State. The Hanford Site is divided into a number of operational areas such as the 200 Areas. In 1989, the U.S. Environmental Protection Agency (EPA) placed the 100, 200, 300, and 1100 Areas on the National Priorities List (NPL) pursuant to the *Comprehensive Response, Compensation, and Liability Act of 1980* (CERCLA). The 200 Areas, located near the center of the Hanford Site, are the focus of this Remedial Investigation/Feasibility Study (RI/FS) Implementation Plan. The 200 Areas NPL site consists of the 200 West Area and 200 East Area (Figure 1-1), which contain waste management facilities and inactive irradiated-fuel reprocessing facilities, and the 200 North Area, formerly used for interim storage and staging of irradiated fuel. Waste sites in the 600 Area located near the 200 Areas are also included in the 200 Area NPL site. There are approximately 700 waste sites organized into 23 waste site groups that will be addressed as part of this Implementation Plan.

This Plan addresses the assessment of waste sites and associated soil contamination (surface and vadose zone) that resulted from past discharges of wastewater to the ground (via ponds, ditches, and cribs) and the burial of solid waste in the 200 Areas and discusses concepts and potential strategies for the eventual remediation of these waste sites. Furthermore, the Plan applies to only those 200 Area waste sites (and associated structures such as pipelines) assigned to the Environmental Restoration (ER) Program consisting of past practice sites and inactive *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) units designated for closure. Monitoring and remediation of 200 Area groundwater is not within the scope of this plan (including the groundwater monitoring required as part of TSD unit closures). Although potential impacts to groundwater from vadose zone contamination will be addressed, any groundwater-specific activities are managed under separate groundwater operable units. In addition to excluding groundwater, this plan does not address the waste storage tank farms located in the 200 Areas (or the waste constituents in the vadoze zone resulting from their leakage), other waste management programs, and decontamination and decommissioning (D&D) of facilities or buildings. The use of the term "200 Area waste site" in this document is consistent with this description and scope.

The 200 Areas is the last NPL site on the Hanford Site requiring a major characterization effort. With the 200 Areas assessment and remediation program being in an early and formative stage, the opportunity exists to incorporate and build on efficiencies achieved at other recent cleanup activities at the Hanford Site (particularly the 100 and 300 Area remediation activities). Because of the importance of this effort, the DOE, the EPA, and the Washington State Department of Ecology (Ecology) teamed to develop a more streamlined approach to completing 200 Area waste site cleanups. A series of workshops starting in 1996 between the EPA, Ecology, and the DOE resulted in an overall strategy for characterization and remediation of the 200 Areas. The workshops culminated in the *200 Areas Soil Remediation Strategy – Environmental Restoration Program* (DOE-RL 1996a). Follow-on workshops have continued to more fully develop the streamlining concepts of the strategy. The team's effort focused on three aspects or elements of the cleanup process where meaningful improvements to the process could be achieved. These key elements include integration of regulatory requirements, consolidation of information and streamlining of documents, and application of a consistent approach to characterization.

The teaming of the EPA, Ecology, and the DOE has resulted in a mutual commitment to define and implement a uniform regulatory, documentation, and characterization approach to cleanup in the 200 Areas. This 200 Area RI/FS Implementation Plan addresses each of the key elements and defines the framework for their implementation. Among other things, the implementation plan is intended to provide a sufficient amount of detail to ensure consistency in future 200 Area work considering the broad range of conditions present and realizing that waste site-specific details are to be addressed in work plans. Because additional efficiencies are expected to be seen as the first characterizations are completed, a degree of flexibility is provided to accommodate future improvements.

1.1 GENERAL OVERVIEW OF 200 AREA ASSESSMENT AND REMEDIATION APPROACH

Figure 1-2 provides an overview of the assessment and remediation process that will be followed in the 200 Areas. This includes preparation of documentation (work plans and RI/FS reports), sampling, analysis, evaluation of data, preparation of proposed plans, issuance of Record of Decisions (ROD) and RCRA permit modifications, remediation activities, and final closeout of waste sites. This process is explained in further detail in the remainder of the sections of this document, beginning with the development of an integrated regulatory approach.

A regulatory framework is needed that integrates the RCRA, CERCLA, and *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) requirements into one standard approach to direct cleanup activities in a consistent manner and to ensure that applicable regulatory requirements will be met. Consistency is desired because it facilitates the preparation, review, and approval process, and focuses the effort on achieving the end product rather than on the process. The framework must be sufficiently complete such that all assessment and remediation steps are addressed with an emphasis on near-term needs for characterization.

Similar to regulatory requirements, a common approach is needed to ensure consistency in defining characterization requirements for the various waste groups (i.e., source operable units). Important components in developing the characterization framework include the data quality objective (DQO) process, data collection strategy and methodology, and use of the analogous site approach. As part of the work planning process, assumptions are made regarding the conceptual model, applicable or relevant and appropriate requirements (ARARs), remedial action objectives (RAOs), and remedial action alternatives because they may influence characterization requirements. For example, the identification of preliminary remedial alternatives helps ensure that data needed to evaluate the alternatives are collected. These types of initial assumptions are not expected to vary considerably between work plans and can be defined early in the assessment process to promote a consistent characterization approach.

The consolidation of 200 Area-wide information was identified as an important streamlining element that is intended to simplify future documents (e.g., work plans, closure plans) and to bring together the significant amount of available 200 Area information. Work plans in the past required generic, as well as site-specific or operable unit-specific, information. Generic information included background information about the Hanford Site or NPL site that was repeated in work plan after work plan. A significant amount of historical information on the 200 Areas has been generated over the years. However, the information is often scattered among various types of reports, plans, or drawings. As a result, the need exists to consolidate background and historical information in a single reference. By compiling these types of materials early, work plans need only focus on group-specific or site-specific details.

A determination on how to best organize waste sites in the 200 Areas was the focus of the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997). It was concluded that 23 process-based groupings would be a more efficient approach to characterization than the existing 32 geographically based source operable units. The selection of these 23 waste groups is based on the type of discharge (e.g., solid waste, cooling water, process water, uranium-rich waste) and waste site type (e.g., pond, crib, ditch, burial ground). Table 1-1 identifies the 23 waste groups. These waste groups formed the basis for the change package that modified Tri-Party Agreement operable unit milestones to align with the 23 waste site groupings.

The process-based waste site groupings facilitate the use of the analogous site approach to characterization. The use of the analogous site approach is fundamental to streamlining in the 200 Areas, due to the large number of waste sites (approximately 700) present. This approach allows data collected from representative sites to be extrapolated to similar or analogous sites in the early stages of assessment to support remedial alternative evaluation and selection. Analytical data would ultimately be required at all waste sites, but the collection of these data would be integrated with remedial design data needs to serve a dual purpose. This analogous site approach has been applied effectively in the 100 and 300 Areas.

1.2 PURPOSE, SCOPE, AND OBJECTIVES OF THE IMPLEMENTATION PLAN

1.2.1 Purpose and Objectives

The purpose of the 200 Areas RI/FS Implementation Plan is to define the framework for implementing soil characterization activities in the 200 Areas to ensure consistency in applying regulatory and documentation requirements and in defining characterization requirements, and reaching remedial action decisions. The framework includes, where appropriate, specific direction such as RCRA/CERCLA integration general plans, such as for data management, and assumptions needed to formulate a consistent path forward, such as land use. The Implementation Plan consolidates background information (200 Area geology and operational history) and other work plan materials (preliminary RAOs and remedial action alternatives), allowing future work plans to be more concise.

This Implementation Plan is not intended to provide detailed instructions for the assessment of individual waste sites or groups, but rather direction to be followed in developing group-specific work plan. Site-specific data needs, DQOs, data collection programs, and associated assessment tasks and schedules will be defined as part of the work planning process. The scope of this Implementation Plan is limited to the 23 waste site groups (i.e., source operable units) in the 200 Areas identified in Table 1-1.

The primary objectives of the Implementation Plan include the following:

- Define a regulatory framework for assessment and remediation of 200 Area waste sites.
- Consolidate information on 200 Area site conditions and operational history to serve as a common source of background information.
- Define governing assumptions important to developing a consistent assessment approach or as baseline information common to all work plans including potential ARARs, preliminary land use, preliminary RAOs and remedial action alternatives, and risk assessment.
- Define a consistent approach to waste site characterization.

Sections 1.2.2 through 1.2.5 provide an additional level of discussion on these objectives and indicate where they are addressed within this document.

1.2.2 Regulatory Framework

Defining the regulatory framework allows for a consistent application of the regulatory requirements for all 200 Area waste sites that are covered under this Implementation Plan. This document provides a readily available resource that has been approved by Ecology, the EPA, and the DOE that defines a streamlined and integrated mechanism for addressing the major regulatory drivers for cleanup (RCRA, CERCLA, and the Tri-Party Agreement). This framework will apply to all waste sites, regardless of the regulatory designation (i.e., CERCLA Past Practice [CPP], RCRA Past Practice [RPP], TSD Unit) assigned.

Section 2.0 provides a discussion of the CERCLA and RCRA processes to develop an understanding of the unique requirements of each, as well of the commonalities they share. This is followed by a discussion on how the two sets of requirements will be integrated, documents to be prepared, and opportunities for public involvement. The discussion is organized by the major steps in the cleanup process, starting from work plan development through remediation with an emphasis on near-term characterization activities. A discussion of the entire process is provided to ensure that the approach prescribed in the Implementation Plan accounts for all elements contained in the regulatory drivers.

1.2.3 Background Information, Supporting Plans, and Common Work Plan Materials

A major focus of the streamlining effort was the need to simplify group-specific work plans. Work plans are required by the Tri-Party Agreement (Ecology et al. 1994) and define characterization and remedial decision-making requirements. The contents of these work plans are often prescriptive based on regulatory guidance documents. For example, work plans in the past required discussions of the physical setting (e.g., geohydrology) and operational history, both at the Hanford Site and at the NPL level (i.e., general level), as well as waste site-specific details. Rather than duplicating the general information in all 23 work plans, the Implementation Plan consolidates this material to serve as a primary reference for this information. This allows work plans to focus on group- and site-specific details resulting in a product that is much more concise. Other sections of work plans that are amenable to this approach because they are not expected to vary significantly between work plans include such topics as ARARs and preliminary remedial action alternatives (see Section 1.2.4), and various secondary plans (e.g., data management plan).

Secondary plans provided in the Implementation Plan include the following:

- Appendix A, Quality Assurance Project Plan, which provides the overall quality assurance framework that will be used to prepare group-specific quality assurance plans for characterization.

- Appendix B, General Health and Safety Plan, which provides the general health and safety requirements for field activities for all waste site groups. Activity-specific health and safety plans will be prepared prior to beginning field work.

- Appendix C, Information Management Overview, which describes how data from all assessment activities will be organized. This plan will be applied to all waste site groups; group-specific plans will not be required.

- Appendix E, Waste Management for the 200 Areas Implementation Plan, which describes the general waste management processes and requirements for waste types that might be generated during the course of assessing 200 Area waste sites. Activity-specific waste control plans will be prepared as necessary to identify the specific type, volume, and disposal of wastes.

Section 3.0 summarizes the 200 Area physical setting (Section 3.1) , provides an overview of the operational history of the 200 Areas, and identifies major potential contaminants of concern (Section 3.2). Detailed discussions of these subjects in provided in Appendices F, G, and H, which include the following:

- Appendix F, Physical Setting, includes the general 200 Area topography, meteorology, vadose zone hydrogeology, and groundwater. It also presents natural background concentrations of chemical and radiological analytes and discussions on environmental and cultural resources of the 200 Areas. These data support both the preliminary physical conceptual model and the conceptual exposure model in demonstrating how contaminants are expected to move through the environment and to potential receptors. This section also promotes an understanding of the constraints and adjustments to characterization activities. These details are intended to supplement the summary information presented in Section 3.1. This information will be referenced as needed in future group-specific work plans.

- Appendix G, Waste Site Listing, tabulates all of the 200 Area waste sites included in the scope of this Implementation Plan. It also provides a detailed explanation of each waste site group. Representative waste sites for characterization activities are identified in Table G-1. In addition, information on the history, engineering, and operational features of each various type waste site is presented. This appendix thus summarizes the types of waste streams and waste sites which, in turn, supports understanding of both the waste site groupings and the physical conceptual model. These details are intended to supplement the summary information presented in Section 3.2. This information will be referenced as needed in future group-specific work plans.

- Appendix H, Process Descriptions and Flow Diagrams, describes the organization and historical evolution of the chemical separation processes and waste management activities in the 200 Areas. A series of figures are used to help illustrate the complexities of the major processes undertaken in the canyon buildings, evaporators, and support facilities around the major processing plants. This appendix demonstrates the origin and range of radionuclides in waste streams and shows why certain radionuclides are not considered as analytes. This discussion demonstrates the connection/similarities between processes on site, the resulting similarities in waste stream chemistries/contaminants, and the general interconnectedness that allows waste sites to be grouped. This information is also intended to supplement the summary information presented in Section 3.2.

Finally, Section 3.3 discusses the physical and chemical interactions that may occur when waste is introduced to the soil column including the fate and transport of contaminants, and summarizes the results of previous soil investigations in the 200 Areas. This is used to form a conceptual understanding of contaminant migration in the vadose zone for major contaminants of concern. Section 3.0 and supporting appendices are intended to be sufficiently comprehensive to satisfy the general information requirements of upcoming group-specific work plans and consolidate a large number of diverse references in a readily available primary document.

A recommended outline for group-specific work plans that incorporates the streamlining elements discussed above is provided in Appendix I. Plates I through III identify the locations of the waste sites, by waste group, and also highlight those that are representative sites or TSD units.

1.2.4 Baseline Assumptions

Several components of the work-planning process function as guiding assumptions to the cleanup process. These assumptions are established early in the process, at least in a preliminary manner because they influence characterization needs. Those assumptions that can be addressed early in the process and are not expected to vary considerably among work plans include ARARs, the conceptual exposure model, RAOs, remedial action alternatives, and risk assessment approach.

ARARs capture those regulatory requirements that are pertinent to the cleanup process. Because ARARs form the basis for establishing cleanup levels, the characterization effort (e.g., detection limits) must be compatible with those requirements. A listing of the ARARs considered important to the 200 Areas is included in Section 4.0. Specific ARARs that may change due to site-specific conditions such as land use, exposure pathways, and remediation goals will be addressed in the group-specific work plans.

Section 5.0 develops a preliminary conceptual exposure model that integrates the waste site categories (source terms) identified in Section 3.2, general contaminant transport phenomena presented in Section 3.3, and land-use considerations with potential exposure pathways and receptors to provide a basis for evaluating current or potential future risks. These risks are then addressed by preliminary RAOs and preliminary remediation goals (PRGs) that are protective of human health and the environment. Based on the RAOs, viable remedial action alternatives are assembled in Appendix D. The remedial alternatives are general and cover a range of technologies to reflect the potential contamination conditions present in the 200 Areas. Appendix D is intended to satisfy the requirements of a screening phase feasibility study (FS) (i.e., Phase I and II FS) by providing the necessary basis to prepare group-specific detailed FSs. Site-specific refinements of the alternatives presented in Appendix D will be made in final group-specific FSs. By completing a screening-level FS in Appendix D and identifying viable alternatives now, a more streamlined RI/FS can be performed. Characterization needs can be more focused if a range of expected remedial alternatives are identified early, and treatability testing needs can also be evaluated and implemented early in the process. The final group-specific FS can then be focused on the detailed analysis of a few viable alternatives.

Sections 4.0 and 5.0 are intended to satisfy work plan requirements for ARARs, the conceptual exposure model, and preliminary RAOs and remedial action alternatives. As such, these subjects will be referenced in future work, although some refinement may be needed based on group-specific conditions.

1.2.5 Characterization Approach

A consistent framework for defining characterization needs for each of the waste site groups is a critical element to a more streamlined cleanup process. Important components of this framework include the following:

- Integration of past practice and RCRA TSD unit characterization needs into a single approach (addressed in Section 2.0)
- Grouping of waste sites based on historical process information and waste site type (ponds, cribs, burial grounds, etc.) (addressed in Section 3.0)

- Prioritization of waste groups according to both technical and administrative criteria (addressed in Section 3.0)
- Development of a preliminary conceptual exposure model (addressed in Section 5.0)
- Recognizing that ARARs, RAOs, and remedial alternatives may influence characterization needs (addressed in Sections 4.0 and 5.0)
- Consistent uniform process of developing DQOs with a team composed of representatives from DOE, EPA, Ecology, and support contractors
- Application of the analogous site concept supported by a phased approach to data collection
- Use of proven characterization methodologies.

The first four bullets lay the foundation for establishing characterization needs and were discussed previously. The last three bullets focus on specific aspects of the characterization approach for waste sites and associated soil contamination (i.e., source term) and are addressed in Section 6.0.

Section 6.0 establishes the process that will be used in group-specific work plans to establish DQOs. This is followed by a description of how characterization for all waste site groups will use the analogous site approach, which focuses characterization efforts on a limited number of specific waste sites that best represent the group. The representative site data will then be used to make remedial action decisions for all sites within a group. A phased approach to data collection is defined that acknowledges the need to sample all waste sites to confirm that remedial action decisions, based on the analogous site approach, are appropriate, as well as providing data needed to design and implement the remedy. Following remediation, verification sampling will be performed to confirm that cleanup goals have been achieved. This phased approach to data collection allows for more efficient use of available resources. This framework provided in Section 6.0 serves a common starting point that will result in consistent data sets for consistent remedial decision making throughout the 200 Areas and to ultimately support site close-out and cumulative effects analyses.

1.3 PROJECT MANAGEMENT AND INTEGRATION

The objectives of project management during the implementation of the RI/FS plans are to ensure the safety of the work force and the affected environment, direct and document project activities, ensure that data and evaluations meet the goals and objectives of the project, and to administer the project within budget and schedule. Section 7.0 describes the approach to management of the 200 Area remediation project, the current project schedule, and the public participation process. As group-specific tasks are defined during the work planning process, task-specific project management plans will be prepared, as needed.

Section 7.0 also contains a discussion of programmatic integration needs with respect to programs inside the ER project, as well as other non-Environmental Restoration Contractor (ERC) programs involved in the 200 Areas. This aspect to project management is necessitated by the diversity of activities (e.g., groundwater pump and treats and tank waste remediation) in the 200 Areas. Although each of these programs has its own unique mission and functions independently, there are also commonalities and shared objectives (e.g., cleanup) that can be integrated to enhance overall effectiveness. In recognition of the diversity of activities on the Hanford Site and the high priority placed on the protection of groundwater and the Columbia River, the DOE has established the Groundwater/Vadose Zone (GW/VZ) Integration Project. The GW/VZ project is responsible for integrating all activities, in various DOE programs, associated with characterization and cleanup activities of the vadose zone and groundwater on the Hanford Site, and protection of the Columbia River. The *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities* (DOE-RL 1998a) report, describes the GW/VZ Project team approach for (1) achieving effective integration of current and planned site-wide activities and (2) sustaining management control of that integration. The 200 Area soil assessment and remediation work addressed by this Implementation Plan is one portion of the ER project that will interface with the GW/VZ Project.

Although groundwater contamination is an essential component of any source term evaluation and impacts to groundwater from vadose zone contamination will be assessed as part of the 200 Area waste site characterization effort, the implementation of groundwater remedial actions is managed under the Environmental Restoration Project's Groundwater Remediation Project. One situation where integration is required pertains to RCRA TSD units where groundwater must be addressed as part of a waste site's closure plan. Because of these kinds of interrelationships, DOE has created the GW/VZ Integration Project. This Implementation Plan outlines how assessment and remediation activities will be performed at 200 Area waste sites assigned to the ER program and, as such, will serve as an important coordinating document to support GW/VZ Integration Project efforts.

Figure 1-1. Hanford Site and Area Designations.

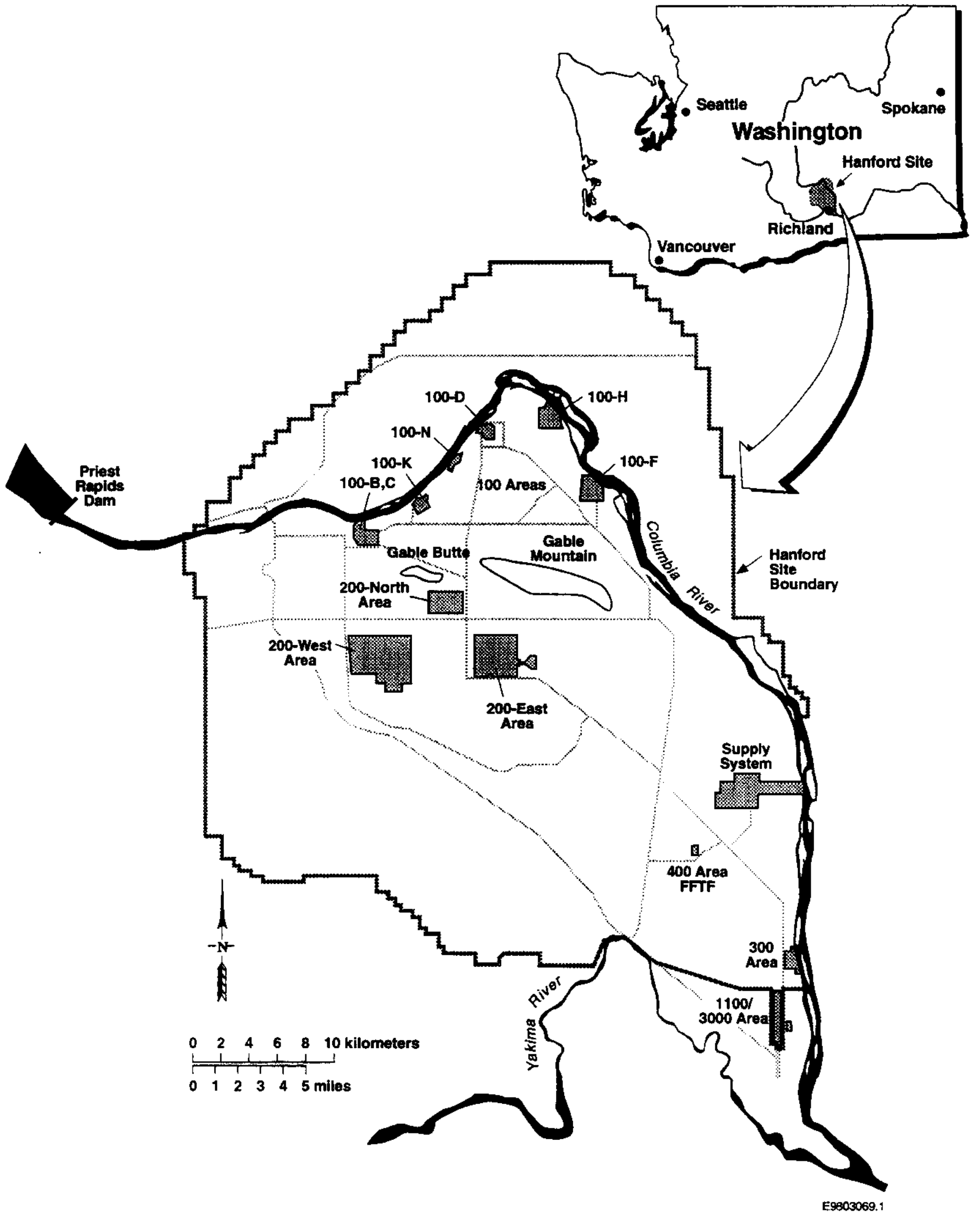
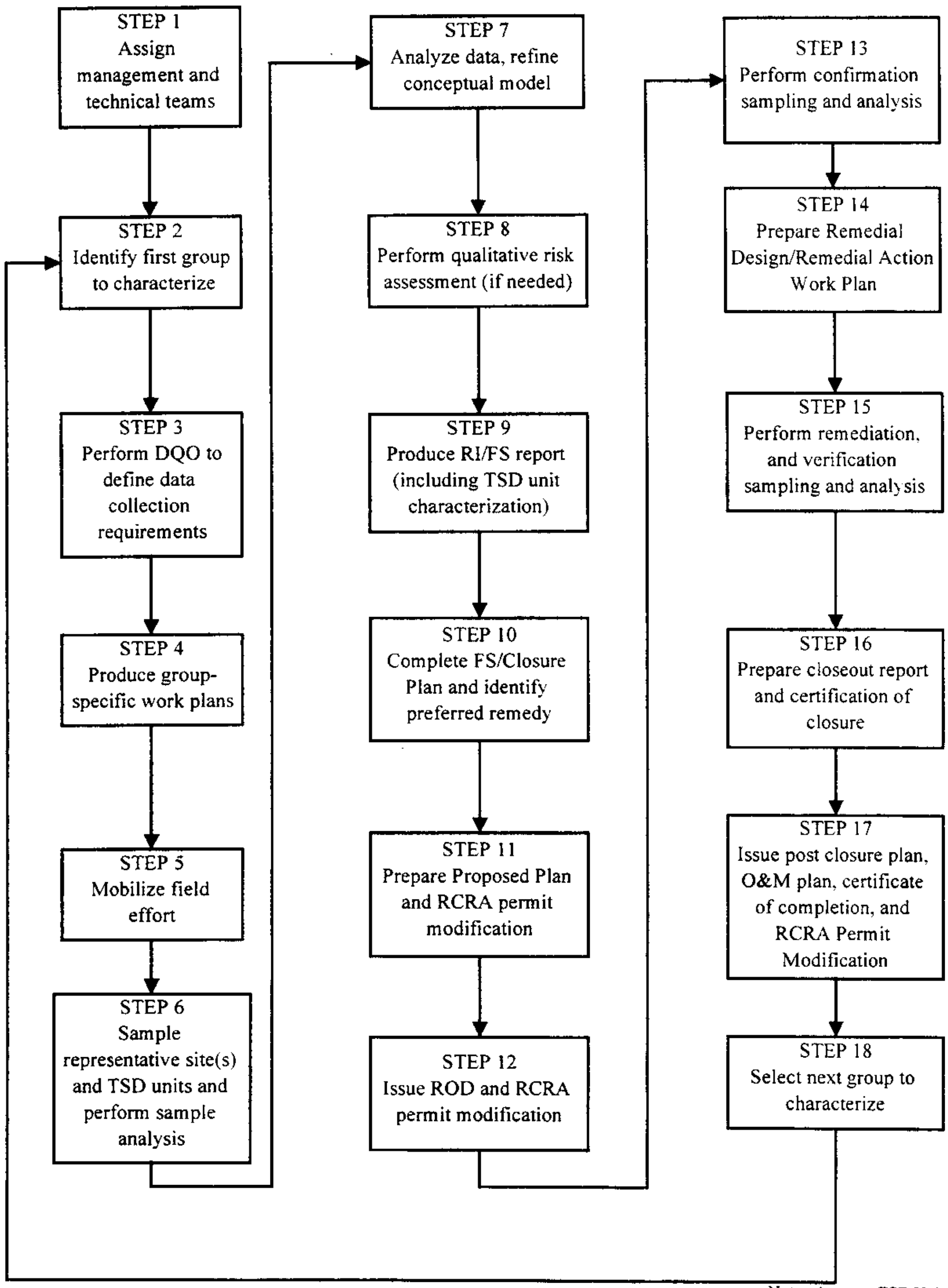


Figure 1-2. General RCRA/CERCLA Past Practice Waste Site and RCRA TSD Unit Process Flow.



Note: Assumes TSD Units are included in the group being worked.

Table 1-1. 200 Area Strategy Waste Site Groupings List.

Process Condensate/Process Waste Category	
Plutonium/Organic-Rich Process Waste Group	200-PW-1
Uranium-Rich Process Waste Group	200-PW-2
Organic-Rich Process Waste Group	200-PW-3
General Process Waste Group	200-PW-4
Fission Product-Rich Process Waste Group	200-PW-5
Plutonium Process Waste Group	200-PW-6
Steam Condensate/Cooling Water/Chemical Sewer Category	
Gable Mountain/B-Ponds and Ditches Cooling Water Group	200-CW-1
S Pond and Ditches Cooling Water Group	200-CW-2
200 North Cooling Water Group	200-CW-3
T Pond and Ditches Cooling Water Group	200-CW-4
U-Pond/Z-Ditches Cooling Water Group	200-CW-5
Steam Condensate Group	200-SC-1
Chemical Sewer Group	200-CS-1
Chemical Waste Category	
300 Areas Chemical Laboratory Waste Group	200-LW-1
200 Areas Chemical Laboratory Waste Group	200-LW-2
Miscellaneous Waste Category	
Miscellaneous Waste Group	200-MW-1
Tank/Scavenged Waste Category	
Scavenged Waste Group	200-TW-1
Tank Waste Group	200-TW-2
Tanks/Lines/Pits/Diversion Boxes Category	
Tanks/Lines/Pits/Boxes Group	200-IS-1
Unplanned Releases Category	
Unplanned Releases Group	200-UR-1
Septic Tank and Drain Fields Category	
Septic Tank and Drain Fields	200-ST-1
Landfills and Dumps Category	
Non-Radioactive Landfills and Dumps Group	200-SW-1
Radioactive Landfills and Dumps Group	200-SW-2

CS – Chemical Sewer
CW – Cooling Water
IS – Infrastructure Systems
LW – Chemical Waste
MW – Miscellaneous Waste
PW – Process Wastes
SC – Steam Condensate
ST – Septic Tank and Drain Fields
SW – Solid Waste
TW – Tank/Scavenged Waste
UR – Unplanned Release

2.0 RATIONALE AND APPROACH TO INTEGRATION OF RCRA AND CERCLA PROCESSES

2.1 INTRODUCTION

2.1.1 Purpose

The purpose of this section is to describe the RCRA and CERCLA processes, provide an integrated regulatory process for remediation of waste sites in the 200 Areas, and to identify regulatory approaches that will be incorporated into the work planning to streamline waste site assessment and provide flexibility in remediation.

Two major regulatory programs govern cleanup of contaminated waste sites at the Hanford Site, RCRA (as amended by the *Hazardous and Solid Waste Amendments of 1984* [HSWA]) and CERCLA. The authority to implement the majority of the RCRA program has been delegated to the State of Washington and is implemented via the *Hazardous Waste Management Act of 1982*. The Tri-Party Agreement, first issued in 1989, was developed by the DOE, the EPA, and Ecology to establish how these programs would be applied at the Hanford Site. As part of the Tri-Party Agreement development, all waste sites at Hanford were designated as either RCRA or CERCLA sites. The 200 Area waste sites addressed in this Implementation Plan are a mix of the types. The RCRA and CERCLA programs have similar objectives and overall approaches for making and implementing cleanup decisions, but there are many procedural elements of the two programs that are dissimilar. The differences can lead to inconsistency and redundant work. As part of the *200 Areas Soil Remediation Strategy* (DOE-RL 1996a), the Tri-Parties committed to integrating RCRA and CERCLA to the fullest extent allowable within the regulatory requirements. This is consistent with the Tri-Party Agreement, which states that the RCRA and CERCLA cleanup programs are functionally equivalent and encourages integration of the two. However, the Tri-Party Agreement does not define a clear and detailed process for integration.

The details of the integrated process are provided in this section. Section 2.1.2 provides basic background information concerning RCRA, CERCLA, the Tri-Party Agreement, and the Hanford Facility RCRA Permit. Sections 2.2 and 2.3 describe the RCRA and CERCLA programs, respectively, at the Hanford Site. Section 2.4 presents the detailed requirements of the standard RCRA and CERCLA programs and of Hanford-specific regulatory agreements, then describes the details of the integrated approach and how that approach satisfies the requirements of the individual programs. For ease of presentation, the requirements and integrated approach are divided into five remediation elements: characterization, evaluation of alternatives, decision-making, implementation, and closeout.

Several regulatory streamlining concepts that have been successfully used at the Hanford Site can be considered in the 200 Areas to reduce the time and budget required for waste site assessment and provide flexibility to address changes needed during remediation. Section 2.5 describes these regulatory approaches and discusses applying them within the integrated regulatory framework.

This integrated regulatory process will support development of future documents, from the work planning phase through RCRA permitting commitments and removal of the 200 Area waste sites from the NPL. It is intended that this section be incorporated by reference in future documents, avoiding the necessity to provide detailed integration discussions in individual waste group specific documents.

2.1.2 Regulatory Overview

This section provides an overview of the RCRA and CERCLA programs and the two Hanford-specific regulatory agreements by which they are implemented, the Tri-Party Agreement and the Hanford Facility RCRA Permit. In general, RCRA was enacted to prevent and address releases at active facilities that generate, store, treat, transport, or dispose of hazardous wastes or hazardous constituents. CERCLA was enacted to investigate and respond to releases and potential past releases of hazardous substances. Cleanup under the RCRA and CERCLA programs is similar in several key respects:

- A primary objective of both programs is to ensure that environmental impacts associated with past and present activities are investigated and that appropriate response actions are taken to protect the public health, welfare, and the environment.
- Many similar criteria are used to evaluate cleanup of contaminated sites.
- Both programs rely on involvement from the public to determine the most appropriate actions for site cleanup.
- Cleanup processes are somewhat similar in both programs. The common steps are:
  - Characterization
  - Evaluation
  - Decision-making (including public involvement)
  - Implementation
  - Closeout.

The programs have differences as well, including:

- Radionuclides are not regulated under the RCRA program. CERCLA, on the other hand, does have authority over cleanup of radionuclides.
- The degree of public involvement may differ. Under RCRA, the responsible owner may independently evaluate cleanup alternatives and provide a recommendation to the public for consideration. CERCLA encourages public involvement throughout the evaluation process such that the public is more integrally involved in determining the recommended response action. However, with both programs, the regulatory agency generally cannot make a final decision without public input.
- No permits are required under CERCLA, but RCRA corrective action sites and TSD unit cleanup actions are required to be included in the Hanford Facility RCRA Permit.
- The State of Washington has been delegated authority to oversee a major portion of RCRA. There are currently no provisions in CERCLA to delegate authority to the state.
- RCRA TSD closure regulations contain specific requirements for cleanup such as permit conditions, enforceable schedules, certifications of closure and postclosure, survey plats, and notices in deed. RCRA TSD units are also specifically defined in regulation and require that the operating unit, spill areas, and ancillary piping be included in the cleanup actions.

The Tri-Party Agreement, initially issued in May 1989, contains provisions governing RCRA and CERCLA cleanup activities at the Hanford Site and delineates the roles of the EPA, Ecology, and the DOE. The general purposes of the agreement are to:

- Ensure environmental impacts associated with activities at the Hanford Site are investigated and that appropriate response actions are taken to protect human health and the environment
- Provide a framework for permitting RCRA treatment, storage, and disposal (TSD) units and provide an orderly and effective investigation and cleanup at the Hanford Site
- Ensure compliance with RCRA and the *Washington Hazardous Waste Management Act of 1976*, as amended
- Establish a procedural framework for developing, prioritizing, implementing, and monitoring appropriate response actions in accordance with CERCLA and RCRA
- Facilitate coordinated participation of the parties in carrying out actions
- Minimize duplication of analysis and documentation.

A key feature of the Tri-Party Agreement is that it encourages integrating RCRA and CERCLA requirements to the greatest extent practicable.

The Hanford Facility RCRA Permit became effective in September 1994 and governs RCRA issues at Hanford. It is composed of two portions: a Dangerous Waste Portion, issued by Ecology, and a HSWA portion, issued by the EPA (see Table 2-1 for a summary of the Permit). (Subsequent to issuance of the Permit, the State of Washington was authorized to oversee portions of HSWA, but Ecology has not yet incorporated HSWA requirements into its portion of the Permit.)

Because it was not possible to permit all of the RCRA units at the Hanford Site simultaneously, the initial Permit was issued for only some units at the facility, with the expectation that additional units will be added over time until all RCRA units at Hanford are covered.

2.2 RESOURCE CONVERSATION AND RECOVERY ACT PROCESS DESCRIPTION

In 1976, Congress enacted RCRA to provide cradle-to-grave management of hazardous waste by generators, transporters, and owners of hazardous waste TSD facilities. The federal RCRA program has jurisdiction over waste with chemical constituents (hazardous waste) and mixed waste (mixtures of hazardous waste and radiological constituents), but does not have jurisdiction over waste containing only radiological contaminants. Only waste that has been generated or managed after the effective date of RCRA authority is designated as hazardous waste, and only waste units that managed hazardous waste are referred to as TSD units[1]. TSD units are subject to the closure and post-closure provisions of RCRA.

[1] "TSD units" are units that store hazardous waste onsite for greater than a 90-day period or that treat hazardous waste, or that manage hazardous waste in land-based units such as surface impoundments, landfills, or waste piles after the effective date of RCRA.

The HSWA amendments to RCRA were enacted in 1984. HSWA provides for corrective action at RCRA past practice (RPP) units[2] at the Hanford Site. Federal regulations implementing RCRA corrective action have been proposed but have not been finalized.

In 1986, pursuant to Section 3006 of RCRA, the EPA authorized the State of Washington to administer and enforce a state hazardous waste management program in Washington. The state dangerous waste[3] management program is similar to, but in some cases broader and more restrictive than, the federal RCRA program. For example, the state program defines a broader scope of constituents to be addressed during corrective action. In addition, in 1996 the state received authority to carry out key portions of HSWA. Ecology implements the dangerous waste management and corrective action programs via the *Washington Hazardous Waste Management Act of 1976*, the Dangerous Waste Regulations, Chapter 173-303 of the *Washington Administrative Code* (WAC), and facility-specific permits.

Any facility in the State of Washington where it is proposed to treat, store, or dispose of dangerous waste must be permitted under state regulations[4]. Ecology may issue a permit for a dangerous waste facility after review of the permit application documentation, which is submitted by the proposed owner/operator of the facility. The permit typically specifies closure requirements for TSD units and corrective action requirements for SWMUs at the facility. TSD units at Hanford are permitted for operation, closure, and/or post-closure care. Existing facilities normally operate under interim status while they await a final permit. An application for interim status was submitted for each known active and inactive TSD at Hanford. The Dangerous Waste Portion of the Hanford Facility RCRA Permit initially incorporated five TSD units. The HSWA Portion contained no non-TSD SWMUs managed by the DOE. The Permit subsequently has been modified to incorporate additional TSD units, and will continue to be modified at least annually to incorporate the remaining Hanford TSD units. The schedule for this incorporation process is included in the Hanford Facility RCRA Permit. Until TSD units are incorporated, they remain in interim status. The 200 Area TSD units that are addressed in the 200 Areas Strategy are listed in Table 2-2 along with their status as of fall, 1998. All TSD units ultimately must be incorporated into the permit. None of these units are continuing to receive dangerous waste, and they will be permitted for closure and, as appropriate, post-closure care rather than operation.

2.2.1 TSD Closure

TSD closure is addressed by the state regulations, the Tri-Party Agreement, and the Hanford Facility RCRA Permit. State TSD closure requirements apply to all units used to store, treat, or dispose of hazardous waste after November 19, 1980; state-only dangerous waste[5] after March 12, 1982; and units at which such wastes will be stored, treated, or disposed in the future, except where otherwise excepted in the regulations. The Hanford TSD units are listed in Appendix B of the Tri-Party Agreement, which also provides criteria by which the units will be scheduled for permitting and closure. Figure 2-1 graphically summarizes the standard TSD unit closure including key documentation, approvals, and public

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[2] Under state and federal authorities, corrective action applies to all solid waste management units (SWMUs) within a facility that is subject to a RCRA permit, irrespective of the date that wastes were placed in the units. SWMUs are discernible locations where solid wastes have been placed at any time, irrespective of whether the location was intended for the management of solid or hazardous waste. SWMUs include any area where solid wastes, including spills, have been routinely and systematically released. Under the state corrective action regulations, the definition of SWMU encompasses TSDs and single spill sites. It can also include sites that are regulated under CERCLA authority. At the Hanford Site, SWMUs fall into three categories: TSDs (sites defined by the date of waste disposal), CERCLA past practice (CPP) (sites that are being addressed under CERCLA authority), and RPPs (SWMUs that are not being addressed as either TSDs or CPPs).

[3] The State of Washington uses the term "dangerous waste" to encompass both those wastes that would be designated as hazardous wastes under the federal RCRA program and other wastes that would not be designated under the federal RCRA program but that the state has determined require similar management.

[4] An exception is onsite CERCLA units, such as the ERDF, that do not require permitting and that may receive RCRA-regulated wastes if authorized by a CERCLA decision document.

[5] "State-only" dangerous waste refers to waste that would not be designated as hazardous waste under the federal RCRA program but that is designated as a dangerous waste under the more broadly applicable state program implementing RCRA.

involvement processes. Closure requirements are specified in WAC 173-303-610 and focus on closure performance standards and the preparation, content, and approval process of a closure plan. Closure plan requirements are described in Section 2.4.3. General TSD closure performance standards are specified in WAC 173-303-610(2)(a). They require that TSD units be closed in a manner that:

- Minimizes the need for further maintenance

- To the extent necessary to protect human health and the environment, controls, minimizes, or eliminates post-closure escape of dangerous waste, dangerous constituents; leachate; contaminated run-off; or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere

- Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity.

WAC 173-303-610(2)(b) identifies specific closure performance standards, including the following:

- For clean closure, soils, groundwater, surface water, and air must attain the numeric cleanup levels calculated using residential exposure assumptions, according to *Model Toxics Control Act* (MTCA) Method B (WAC 173-340).

- Clean closure standards for structures, equipment, bases, and liners shall be established on a case-by-case basis by Ecology in accordance with WAC 173-303-610(2)(a).

Closure requirements for individual types of waste units (e.g., tanks, surface impoundments) contain provisions wherein the unit can be closed with waste in place in accordance with the closure and post-closure requirements for landfills found in WAC 173-303-665(6). The mechanism for selecting landfill closure depends on the type of waste unit.

Section 6.0 of the Tri-Party Agreement addresses TSD closure and includes the following requirements:

- When a TSD is included in an operable unit, the information necessary for performing RCRA may be provided in coordination with other operable unit cleanup documentation.

- TSD units containing mixed waste will normally be closed with consideration of all hazardous substances, including radioactive constituents. However, provision is made that the CERCLA process can be used to address any radioactive constituents not addressed during the TSD unit closure process. 200 Area TSD units addressed in this Plan will be closed with the intention of addressing all hazardous substances. However, there have been situations in the past in which a 200 Area TSD unit was closed without addressing all the hazardous substances (e.g., radioactive waste). Any CERCLA hazardous substances remaining at those units will be addressed as part of the past practice process as designated for that operable unit (e.g., waste sites 216-B-3A, -3B, and -3C were clean closed previously; remaining radiological waste will be addressed during cleanup of the 200-CW-1 waste group).

- Clean closure must include an evaluation to demonstrate that groundwater and soils have not been adversely impacted by the TSD unit as described in WAC 173-303-645.

- Procedural closure can be used for TSD units that were designated, but were never used, for the treatment, storage, or disposal of dangerous waste. Procedural closure requires a written notification to Ecology stating that the unit never handled dangerous wastes. Ecology will either approve or deny the procedural closure. If procedural closure is denied, permitting and/or another type of closure action would be initiated.

The Dangerous Waste Portion of the RCRA Permit also addresses TSD closure. It reiterates the performance standards of WAC 173-303-610(2) described above and specifies the following options for closure (Section II.K):

- A TSD unit closed to the cleanup levels specified in WAC 173-303-610(2)(b) for all media including waste, debris, soil, and groundwater is deemed a "clean closure."

- TSD units may be closed to background levels as defined in the Hanford Site Background Documents if background concentrations exceed the standards of WAC 173-303-610(2)(b). Closure to these background levels is also deemed a "clean closure."

- If dangerous waste constituents present at the TSD unit at the completion of closure are above MTCA Method B levels but below MTCA Method C levels (WAC 173-340) for all affected media, then a "modified closure" option may be used. A modified closure requires (1) institutional controls to restrict access to the TSD for a minimum of 5 years following completion of closure, (2) periodic assessments to determine the effectiveness of closure, including a compliance monitoring plan, and (3) a post-closure permit.

- When clean closure or modified closure are not chosen, the TSD unit will be closed as a land disposal unit (landfill closure) following the requirements in WAC 173-303-610. For closure as a land disposal unit, a post-closure permit will be required that addresses maintenance and inspection activities, groundwater monitoring requirements, and corrective actions.

Section II.K.7 of the Permit indicates that, where agreed to by Ecology, integration with other cleanup actions can be accommodated by the Permit, and that all, or appropriate parts of multipurpose cleanup documents can be incorporated into the Permit via the Permit modification process. Further, cleanup conducted under any statutory authority that is equivalent to the technical requirements of Permit Section II.K may be considered to satisfy the Permit requirements.

Most of the TSD units addressed in the 200 Areas Strategy are interim status units for which a closure plan and, as appropriate, post-closure plan will be required. The TSD unit-specific schedule for closure is required to be provided in the closure plan. In accordance with the RCRA Permit, activities to complete closure will be scheduled within 180 days of the permit modification adding the closure plan to the permit, unless otherwise agreed upon in the closure plan. A few TSD units addressed in this Implementation Plan are final status units that have been clean-closed for wastes managed at the units. Within 60 days of final closure of any TSD unit, RL must submit a certification of closure to Ecology. Typically, a post-closure plan is submitted at the same time the closure plan is submitted (for land-based TSD units).

2.2.2 RCRA Corrective Action

State corrective action requirements apply to all SWMUs, which includes the RPP waste sites addressed in this Plan, irrespective of the date waste was received. The state corrective action regulations found in WAC 173-303-646 do not specify detailed process or schedule requirements. General corrective action requirements found in WAC 173-303-646(2) specify that corrective action must protect human health and the environment for all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility. Numeric performance standards for corrective action are not specified; however, WAC 173-303-646(3)(c) states that Ecology will incorporate corrective action requirements pursuant to MTCA into permits for those facilities required to have permits. Typically, Ecology establishes corrective action cleanup levels using methods outlined in the MTCA regulation (WAC 173-340).

Section 7.0 of the Tri-Party Agreement (Ecology et al 1996) states that cleanup of past practice sites will be conducted according to either the CERCLA process or RCRA corrective action process. It further states that the two processes are functionally equivalent and, although either process may be used, information contained in any RCRA documents is required to be functionally equivalent to information that would be gathered under CERCLA. Section 7.4 details the RCRA corrective action process, based on proposed federal regulations and guidance. Figure 2-1 graphically summarizes key document preparation, approval, and public involvement processes involved in corrective action.

As stated above, the EPA portion of the Hanford Facility RCRA Permit defines a process for implementing RCRA corrective action at the Hanford Site. However, the EPA section also states that RCRA corrective action that is being performed in accordance with the Tri-Party Agreement is not subject to the process in the permit, and that decisions made via the Tri-Party Agreement process will be incorporated by reference into the permit. Since issuance of the permit, Ecology has been delegated authority for RCRA corrective action. Ecology has not yet defined and incorporated Hanford-specific HSWA requirements into the Permit.

The corrective action/remedial action program in this Implementation Plan will address waste sites and associated contamination within the 200 Areas. It is probable that releases beyond the boundaries of the 200 Areas have occurred. The DOE is undertaking studies of the impacts of these releases and how they will need to be addressed in the final actions for the Hanford Site. Although corrective measures taken in the 200 Areas will reduce the potential for future offsite releases, this performance standard will be addressed in a more comprehensive manner during final remediation of the Hanford Site.

2.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT PROCESS DESCRIPTION

In 1980, CERCLA was enacted to address past releases or potential releases of hazardous substances[6], pollutants, and contaminants to the environment. Pursuant to CERCLA Section 120 and Executive Order 12580, EPA is the federal agency responsible for oversight of DOE's implementation of CERCLA. At the Hanford Site, wastes sites managed under CERCLA are referred to as CERCLA past practice (CPP) units. There is significant overlap between the state corrective action program and CERCLA, and many waste units are subject to remediation under both programs.

The CERCLA program is implemented via the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP), Title 40 Part 300 of the Code of Federal Regulations (CFR). The NCP establishes procedures for responding to releases, including notification and initial assessment of the nature of the release, specific processes for characterization, evaluation, and remediation, and special provisions for federal facilities. Section 7-3 of the Tri-Party Agreement addresses CERCLA implementation at Hanford and is generally consistent with the NCP process. Figure 2-1 graphically summarizes the CPP key document preparation, approval, and public involvement processes.

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[6] "Hazardous substances" means those substances defined by Section 101 (14) of CERCLA. It includes a wide variety of chemicals and radioactive constituents, but excludes petroleum products.

The CERCLA program does not establish specific cleanup levels; rather, it defines acceptable risk levels that form the basis for developing cleanup levels. However, CERCLA does require that all cleanup actions comply with the substantive requirements of federal and state laws and regulations. These substantive requirements are categorized and evaluated for the extent to which they are directly applicable to the CERCLA action or, if not applicable, relevant and appropriate for consideration in evaluating the action. The CERCLA ARARs typically establish the cleanup standards that ensure that the selected remedial action protects human health and the environment. For example, at Hanford a key ARAR in establishing cleanup levels for chemical contaminants is MTCA. Other potential sources of ARARs that provide cleanup standards would be RCRA, the *Safe Drinking Water Act*, and *the Clean Air Act*. Nonpromulgated standards, including DOE orders, proposed regulations, and regulatory guidance, are not ARARs but may be to-be-considered (TBC) materials. An example of a key TBC material used on Hanford cleanups is the EPA policy statement entitled *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* (EPA 1997a). Only the substantive, rather than administrative, requirements, of ARARs apply, and CERCLA specifically exempts onsite[7] cleanup actions from obtaining federal, state, or local permits.

2.4 PROCESS FOR RCRA/CERCLA INTEGRATION

Because the 200 Areas are composed of CPP, RPP, and TSD sites, the Tri-Parties have committed that the cleanup strategies will be integrated to the maximum extent possible. This is consistent with specific recommendations for integration in the Tri-Party Agreement and can be accommodated under the Hanford Facility RCRA Permit. In developing an integrated approach, certain assumptions were made that provide the logic for the recommended process:

- Because of the similarities and the grouping logic, characterization of representative sites and/or TSD units within each of the 23 waste groups will be used to make cleanup decisions for the entire group. All TSD units will be characterized, and if a TSD unit is considered to be representative of the waste group, it will be used as a representative site for characterization of the waste group. TSD units already closed will not require additional characterization for the dangerous waste managed; however, they will require characterization for radionuclides, hazardous substances, and dangerous waste constituents that were not managed by the TSD unit. In some cases, samples taken for characterization of the TSD units or verification of the clean closure were analyzed for radionuclides and other parameters to provide information for the CERCLA program. These data are available in the Administrative Record or in summary form in data evaluation reports that were prepared to present data for the TSD unit closure.

- In general, the preferred waste disposal option is the Environmental Restoration Disposal Facility (ERDF), for Hanford Site-generated remediation waste that meets the ERDF waste acceptance criteria. A CERCLA decision document is required to allow disposal of waste at the ERDF.

- Within each waste group, it is desirable to streamline the document preparation and integrate the public review process.

Figure 2-2 graphically illustrates the integration process that will be used for the 200 Areas Strategy. The CERCLA process will be used as the basis for assessment and remediation activities in the 200 Areas, with modification as needed to concurrently satisfy requirements specific to RCRA permitting for RPP and TSD units. The Tri-Parties selected the CERCLA process for the overall format because it best

[7] "Onsite" in this context means the area of contamination and areas in close proximity required to implement the cleanup action.

accommodates an integrated approach. It should be noted, however, that implementing conditions for corrective action are still being developed and will be incorporated into the Hanford Facility RCRA Permit in the future. It is the intent of the Tri-Parties to implement the most efficient cleanup process. While CERCLA is the preferred process, other options do exist and can be implemented by Ecology to address RPP and TSD sites.

The following sections described the detailed requirements of the individual TSD closure, RCRA corrective action, and CERCLA programs as they are implemented at the Hanford Site, and the integrated process that will be used in the 200 Areas to address the requirements of all three. The sections are divided into five elements: characterization, evaluation of alternatives, decision-making, implementation, and closeout.

2.4.1 Characterization

TSD Closure. WAC 173-303-610 requires that closure plans include an estimate of the maximum waste inventory managed at a TSD, but there are no specific regulatory requirements for characterization of environmental contamination prior to closure of a TSD unit. However, Ecology guidance specifies that closure plans must include a sampling and analysis plan (SAP) to define the nature, degree, and extent of contamination "to the fullest extent possible." The SAP must include information necessary to ensure proper planning and implementation of sampling activities including (1) purpose and objectives; (2) organization and responsibilities; (3) project schedule; (4) information on types and volumes of samples needed; (5) information on sampling locations; (6) specific sampling approach and methods; (7) sampling and analysis procedures to confirm decontamination of tanks, concrete structures; and other media or equipment; (8) procedures for analysis and reporting results; and (9) a Quality Assurance/Quality Control Plan that is included as part of the SAP.

By regulation, TSD closure must consider all dangerous constituents generated or managed at the unit. For some units, this may include all the constituents listed in Appendix IX of 40 CFR 264 and/or WAC 173-303-9905[8]. The Ecology guidance encourages the use of a DQO process to focus the characterization effort. Indicator constituents may be proposed, but the selection of indicator units first must be based on relatively broad-based sampling and analysis for the full range of constituents that might be present. Under the Tri-Party Agreement, TSD closure at the Hanford Site should also normally consider radioactive constituents.

The following standard methods are generally applicable to characterization for TSD closure:

- *Test Methods for Evaluating Solid Waste, Physical Chemical Methods* (EPA 1986, as amended)
- *Methods for Chemical Analysis of Water and Wastes* (EPA 1979, as amended)
- *Standard Methods for the Examination of Water and Wastewater* (APHA and AWA 1992, as amended)

RCRA Corrective Action. The characterization process for RCRA corrective action consists of three parts: the initial assessment, planning, and characterization/reporting. The initial assessment is called a RCRA facility assessment (RFA). At the Hanford Site, the lead regulatory agency may require an RFA

[8] The dangerous waste constituents identified in WAC 173-303-9905 were derived from 40 CFR 261, Appendix VIII, Dangerous Constituents. Appendix VIII was used by EPA to develop the Appendix IX list of constituents for the purposes of defining constituents that can be analyzed in groundwater. However, Appendix VIII constituents for which analysis is not feasible are not included in Appendix IX. Also, Appendix IX added a few constituents common at Superfund sites that were not included in Appendix VIII. Thus, from a practical standpoint, the Appendix IX will capture the WAC 173-303-9905 dangerous waste constituents to be analyzed during characterization activities. Dangerous waste constituents also include constituents that cause a waste to be regulated under state-only criteria (WAC 173-303-100) due to biological toxicity or persistence.

of some or all of the RPP units within an operable unit. The requirement is based on whether there is sufficient knowledge about the unit to determine if a facility investigation is needed. If there is already sufficient knowledge indicating that a facility investigation will be required, the RFA process can be bypassed. If the RFA is required, the results of the assessment are documented in a written report.

Under corrective action, the work-planning phase results in a RCRA facility investigation (RFI)/corrective measures study (CMS) work plan. The RFI/CMS work plan generally addresses all sites within an RPP operable unit. As required by the Tri-Party Agreement, TSD units that are also contained within an operable unit should be investigated along with the past practice units, and RFI/CMS work plan should be functionally equivalent to the CERCLA RI/FS work plan. The RFI/CMS work plan assembles available site data that assist in developing a conceptual understanding of the site or operable unit, identifies additional data needs, and identifies potential corrective measure technologies. It also includes a characterization SAP, health and safety and project management plans, and proposed work schedules. The RFI/CMS work plan requires approval from the lead regulatory agency; there is no regulatory or Tri-Party Agreement requirement for a public review.

Corrective action authority applies to all releases of dangerous waste and/or dangerous constituents from SWMUs (WAC 173-303-646[1]). Dangerous wastes are identified via WAC 173-303-070; dangerous constituents are those constituents defined in WAC 173-303-9905 or 40 CFR 264 Appendix IX, or which cause a waste to be listed or designated as a dangerous waste under WAC 173-303, or any hazardous substance under MTCA (RCW 70.105D.020[5])[9]. Although there is no regulatory requirement to sample and analyze for the full universe of dangerous constituents, all of these sources may be considered in identifying constituents that should be characterized. As required by the Tri-Party Agreement, RCRA corrective action at Hanford must also consider radioactive constituents. Sampling and testing methods are identified in WAC 173-303-110 and refer to several guidance documents that provide approved methods to be employed for specific sampling and analysis situations.

The field investigation is called an RFI. The general purpose of the RFI is to characterize the nature, extent, direction, rate, movement, and concentration of releases; determine the potential need for corrective measures; and aid in the selection and implementation of those measures. The results of the RFI are presented in an RFI report. Based on the results of the RFI, the lead regulatory agency may determine that no further investigation or corrective action is required for each past practice unit within the operable unit, or may determine that a corrective measures study is required. The RFI also includes descriptions of human and ecological receptors; analyses of current concentrations and extrapolations of future movement, degradation, and fate of contaminants; preliminary treatability studies; and assessment of risks. The RFI can be phased to accommodate smaller functional units (i.e., operable units, waste groups) at large facilities, such as is done at the Hanford Site.

CERCLA. The characterization process under the CERCLA program is very similar to that for RCRA corrective action. It begins with a preliminary assessment/site inspection that is used as the first screening step to determine whether a site should be placed on the CERCLA NPL. The preliminary assessment/site inspection has been completed at the Hanford Site. For the Hanford Site, the information needed to make that determination was provided to the EPA in 1987. Based on this information, the 100, 200, 300, and 1100 Areas were placed on the NPL as distinct facilities.

[9] MTCA defines a state list of hazardous substances that includes the federal definition of hazardous substances, dangerous waste, petroleum or petroleum products, and any other substance, including solid waste decomposition products, that is determined to be a threat to human health and the environment when released into the environment (for example, MTCA has determined that secondary drinking water contaminants under the federal Safe Drinking Water Act are contaminants of concern). State RCRA corrective actions encompass all of these MTCA hazardous substances.

The scoping activity and work planning occur next and result in an RI/FS work plan. Existing data and information about the individual waste sites within each operable unit are assembled and evaluated. These data are used to support the logic for the RI/FS work plan. The RI/FS work plan involves the assembly and evaluation of available site data and identification of additional data needs, and includes a characterization SAP, data management, quality assurance (QA)/quality control (QC), development of a conceptual understanding of the site or operable unit, and identification of likely RA technologies. The work plan should identify all CERCLA hazardous substances[10] present at the waste site. Specific characterization requirements are identified during the DQO. The RI/FS work plan also establishes health and safety requirements, project management plans, community relations, and proposed work schedules. The RI/FS work plan must be reviewed and approved by the lead regulatory agency; there is no statutory or regulatory requirement for public review. As necessary, the schedule in the work plan is incorporated into Appendix D of the Tri-Party Agreement. As additional information becomes available during the RI/FS process, work plans may be revised.

Once the work plan is finalized, the RI is initiated. It may be presented in a single RI report or, as described in the Tri-Party Agreement, as a series of reports. The purpose of the RI is to define the nature and extent of the contamination and assess needs for treatability tests. The RI first focuses on field sampling and laboratory analysis including characterization of waste types, migration routes, volume, and concentration ranges. CERCLA allows for the characterization constituents to be determined by various methods such as process knowledge, waste disposal history, and previously collected data. CERCLA guidance documents provide methods for specific sampling and analysis situations. The RI includes researching cleanup alternatives and laboratory-, bench-, and field testing cleanup alternatives to evaluate performance and cost. The information obtained ultimately is used to assess risks, identify potential ARARs, establish potential remedial action objectives and cleanup levels, and evaluate remedial alternatives in the FS.

The schedule for the RI is specified in the work plan.

Integrated Process for Characterization. The characterization process for each waste group will consist of the following:

- Preparing this Implementation Plan and a waste group-specific RI/FS work plan, that together will satisfy the requirements for an RI/FS and RFI/CMS work plan
- Conducting the RI, that will also satisfy the requirements for an RFI
- Preparing a waste group-specific RI report, that will also satisfy the requirements for an RFI report.

This Implementation Plan provides general information and approaches applicable to all of the 200 Area waste groups that can satisfy elements of the work planning process or be incorporated by reference in the waste group-specific work plans. The Implementation Plan specifically includes elements that will not be repeated in waste group-specific work plans such as facility background information, potential ARARs, preliminary RAOs, and identification and preliminary screening of remedial technologies.

[10] The CERCLA program applies to all hazardous substances as defined by CERCLA §101(14) and §101(33). The CERCLA hazardous substances list captures most of the Appendix IX list of 40 CFR 264 but includes many other federal program contaminants of concern as well, such as those from the Federal Water Pollution Control Act, the Clean Air Act (which includes radionuclides), and the Toxic Substances Control Act. This list also includes all federally regulated hazardous wastes.

The waste group-specific work plans will address all waste sites in the group and may include any combination of the three site types (TSD, RPP, and CPP). The waste group-specific work plans will be developed on a schedule that has been agreed upon by the Tri-Parties and incorporated into the Tri-Party Agreement. An abbreviated outline of a waste group-specific work plan is provided in Appendix I. The work plans will document background information specific to the waste group and sites within the group and define group-specific characterization and assessment activities and schedule based on the framework established in this Implementation Plan. A DQO will be conducted in support of each work plan as described in Section 6.0 of this Implementation Plan. The DQO will be used to define the chemical and radiological constituents to be characterized and details regarding number, type, and location of samples at representative sites within the waste group and specific analytical requirements not otherwise provided in the Quality Assurance Project Plan (QAPjP) included in Appendix A of this Plan. In identifying chemical constituents to be considered, the universe of constituents will include CERCLA hazardous substances (including radionuclides), MTCA hazardous substances (including dangerous and extremely hazardous wastes, petroleum and petroleum products, and secondary drinking water contaminants), and dangerous waste constituents as identified in WAC 173-303. The integrated list of CERCLA and MTCA hazardous substances will be used as the starting point for determination of site-specific contaminants of concern. Available characterization data (e.g., waste stream analyses) and information regarding historical processes will be used to the extent that they are documented to identify the contaminants that might be present in the specific waste group. The DQO process will then be used to further refine this list and determine which of these constituents should be considered potential contaminants of concern (COPC) for the waste group. These COPCs will be sampled and analyzed for during site characterization activities (see Section 6.0).

A characterization SAP will be prepared based on the DQO. The Ecology closure plan guidance will be consulted to ensure that the SAP addresses the elements required in a TSD SAP. The work plan will compile available data, summarize the DQO, provide the characterization SAP, and establish the schedule for conducting future phases of work. The work plan must be approved by the lead regulatory agency. In addition, the work plan, including the characterization SAP, will be available to the public during the review of the proposed plan and RCRA permitting activities.

This Implementation Plan contains an initial screening of the universe of remedial technologies (Appendix D). That screening will be incorporated by reference and refined as needed in the waste group-specific work plans.

The waste group-specific RI/FS work plan will fulfill the requirements of an RFI/CMS work plan and an RI/FS work plan. For those waste groups where TSD units are present, it will also be used to fulfill several TSD closure plan requirements by providing the following:

- A characterization SAP
- Facility description and location information
- Process information
- Waste characteristics
- Groundwater monitoring (a summary and evaluation of data collected as part of the existing monitoring programs).

Before or during the work-planning process, all CPP and RPP sites will be evaluated to determine whether there are any sites that may be reclassified as "rejected," "closed out," "deleted from NPL," or "no action" sites. Tri-Party Agreement Handbook Guideline (DOE-RL 1990) TPA-MP-14 will be used for this purpose to reclassify sites. Reclassified sites will be kept in a separate list for tracking purposes. Candidates for reclassification may include instances where:

- Waste disposal facilities were constructed but not used
- Duplicate labeling exists for a waste site produced by an unplanned release
- Sites have been cleaned up
- Contamination has decayed to background levels
- Sites were misclassified as a waste site
- Voluntary action such as a housekeeping activity may be used to remediate the site.

All reclassifications will be supported by data packages provided to the Tri-Party Agreement reclassification team and will require approval by the team.

After the work plan is approved, the RI will be initiated. Field efforts for characterization of CPP, RPP, and TSD units in a given waste group will be conducted concurrently to take advantage of mobilized field personnel. The results of the RI will be documented in a group-specific RI report for all TSD, RPP, and CPP units characterized during RI in the waste group. The RI report will be submitted to the lead regulatory agency for review and approval in accordance with the schedule specified in the work plan.

Although there is no specific requirement for public review of RFI/CMS or RI/FS work plans, it is the intention of the DOE and the regulatory agencies to provide both this Implementation Plan and the first several waste group-specific work plans for public review and comment. Any public comments received will be used to help identify improvements in the work planning process. For the remaining waste group-specific work plans that include TSD units, public comment will be requested on those portions of the work plan that are referenced in the closure plan or that are incorporated into the closure plan. Responsiveness summaries to closure plan comments will be provided to the public in the RCRA Permit modification administrative record.

2.4.2 Evaluation of Alternatives

TSD Closure. A RCRA closure plan (WAC 173-303-610 and –806) is developed to address and ensure compliance with the closure requirements of the Dangerous Waste Regulations (WAC 173-303) and the Hanford Facility RCRA Permit. The closure plan is a detailed description of proposed procedures to close a dangerous waste unit or facility. The plan must describe methods for removing, transporting, treating, storing, or disposing of all dangerous waste, when such waste will be generated as part of closure. The closure plan consists of nine basic chapters that provide facility description and location information, process information, waste characteristics, groundwater monitoring, closure strategy and performance standards, planned closure activities, and the post-closure plan. It also includes a SAP that addresses sampling to characterize the TSD unit prior to implementing closure activities and sampling at the completion of field activities to verify that closure performance standards have been met. Ecology's *Guidance for Clean Closure of Dangerous Waste Facilities,* (Publication 94-11), will be used as guidance in the development of RCRA closure plans. Ecology's review of the closure plan evaluates information such as the following in determining whether to approve the plan:

- How and when the facility will be closed

- How closure requirements will be carried out including compliance with closure performance standards and procedures for removal of wastes
- An estimate of the maximum amount of dangerous wastes that can or have been treated or stored at the facility
- Procedures for sampling and analysis
- The steps proposed to decontaminate facility equipment
- The expected year closure will begin and a schedule for the completion of closure
- Estimates of costs for closure (for information purposes only).

A closure plan only needs to identify a single closure option, if one has been identified that meets the performance standards and requirements; there is no requirement to discuss other closure alternatives. However, if a decision on the closure option has not been made, then all contingent closure activities/pathways must be included in the closure plan. As described in Section 2.2.1, there are several closure strategies available at Hanford consisting of clean closure, modified closure/post-closure, and landfill closure/post-closure. One or all closure options may be applicable for closure of a TSD. Part of the closure plan development is an evaluation to determine the closure option that will be used. Section II.K.5 of the Hanford Facility RCRA Permit requires that the selected option consider potential future site use for the TSD site/area.

State regulations and section II.W of the Hanford Facility RCRA Permit require that any work performed under the Permit (including TSD closures) comply with any other applicable laws and regulations (e.g., air emission standards). This includes provisions to obtain permits. These other requirements and permits are typically identified in the closure plan.

Facilities that will leave wastes in the ground and/or contamination in groundwater after closure must be closed as a modified or landfill closure and must prepare a post-closure plan (WAC 173-303-610 and -806). This plan details how the owner/operator will maintain the facility to ensure wastes remain where they were placed. Post-closure plans must be written to meet final status standards and are required for any regulated unit that received waste after July 26, 1982, or that certified closure after January 26, 1983. Post-closure requirements are applicable to land-based TSD units, tank systems that must be closed as land-based units, and any area that cannot be cleaned up to meet clean closure standards. Post-closure plans are subject to public review. The approved post-closure plan becomes a part of the permit via the permit modification process.

The closure plan (and post-closure plan, if required) is provided to Ecology for review and approval. They are then made available for public review and comment during the public comment period on the draft permit modification (see Section 2.4.3). Any modifications of the closure plan/post-closure plan are subject to Ecology review and approval and public review and comment in accordance with the permit modification process specified in WAC 173-303.

RCRA Corrective Action. Under RCRA corrective action, the evaluation of cleanup alternatives is performed in a CMS. Unlike a TSD closure, consideration of two or more alternatives is generally part of the CMS. A CMS includes identification and development of the corrective measure alternatives, an evaluation of the alternatives, and a justification for a recommended alternative. It also includes a cost estimate for each alternative considered. The CMS concludes by recommending an alternative. The

CMS report becomes the basis for revision of the RCRA permit through the modification process in which the recommended corrective action is documented. The Tri-Party Agreement requires that the information obtained through the CMS must be functionally equivalent to the information obtained in the CERCLA FS process. The CMS report is made available for public review and comment as part of the draft permit modification package.

Activities conducted as part of RCRA corrective action must comply with any other applicable laws and regulations (e.g., air emission standards).

CERCLA. Under CERCLA, cleanup alternatives are evaluated and reported in an FS. The FS typically summarizes information on the nature and extent of contamination and the risk assessment from the RI report, identifies and screens potential cleanup technologies, and provides a detailed evaluation and comparison of potential cleanup alternatives. The FS may be conducted in a single step or, as described in the Tri-Party Agreement, in multiple phases.

If the cleanup action is focused on a limited area, a limited set of constituents, or a limited set of cleanup technologies, a focused FS may be prepared. When the scope of the remedial action is limited (e.g., few contaminants, a limited range of alternatives) or targeted to address a specific exposure pathway rather than all pathways, it may be appropriate to "focus" characterization and assessment activities. Focusing is achieved by limiting the characterization effort to collect only those data needed to address the scope, initiating formal evaluations of remedial technologies during work scope development, and reducing the number of alternatives to be evaluated during FSs. Further efficiencies can sometimes be realized if treatability studies are initiated early in the program. The number of alternative treatment technologies that would be evaluated in a focused FS could be limited because the existence of few known effective and technically feasible remedial technologies available to address the particular site problems, recent remedial action experience at similar sites, or applicability of particular ARARs that might constrain the number of alternatives capable of meeting ARARs as required by the NCP.

The first step in the FS involves identifying all possible remedial technologies that are applicable to the type of contaminants and conditions found at the waste site. This step can be performed before the RI has been completed. The technologies are then screened to reduce the number of cleanup/treatment alternatives that will be evaluated in detail. This process is accomplished by considering the technologies based on effectiveness, implementability, and cost. Finally, the most promising technologies are assembled into alternatives, analyzed against nine CERCLA evaluation criteria, then compared to one another. The nine criteria are (1) overall protection of human health and the environment; (2) compliance with the ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance. These criteria are divided into three categories: threshold, balancing, and modifying criteria. The first two criteria (threshold criteria) determine which alternatives are eligible for consideration. The next five criteria (balancing criteria) help describe relative technical and cost differences. The last two criteria (modifying criteria) may prompt remediation plan changes based on the state's and community's comments and concerns. DOE Order 451.1 requires DOE CERCLA documents to incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable in lieu of preparing separate NEPA documentation for CERCLA activities. At the Hanford Site, this is accomplished by evaluating the alternatives against NEPA values as a tenth criterion, in addition to the nine CERCLA criteria.

In contrast to the CMS, no specific recommendation is made in the FS regarding a preference for any of the alternatives. The FS is then submitted to the lead regulatory agency for review and approval. Once the regulatory agency has accepted the report, it is made available to the public during the comment period on the proposed plan.

As discussed in Section 2.3, CERCLA activities are required to comply with both applicable *and* relevant and appropriate requirements contained in other laws and regulations. However, onsite CERCLA activities are only required to comply with the substantive portions of those requirements and not administrative requirements, such as requirements related to obtaining permits.

Integrated Process for Evaluation of Alternatives. After characterization is complete, remedial alternatives/closure strategies will be developed and will be evaluated against performance standards and evaluation criteria. This evaluation will be used to satisfy the TSD requirement for determining what type of closure is practicable and can be achieved.[11] The results from this process will be a waste group-specific FS/closure plan. The format will follow the standard format of a CERCLA FS with the following modifications:

- If the waste group includes a TSD unit(s), a closure plan addressing the TSD units will be added to the FS as an appendix. The closure plan will do the following:
  - Incorporate by referencing the specific page and line number of the waste group-specific work plan or reproduce work plan text or modified text into the closure plan for Facility Description and Location, Process Information, Waste Characteristics, Groundwater Monitoring, and the characterization SAP. Should information from waste group-specific work plans be outdated or require modification, new text will be added to the closure plan.
  - Incorporate by referencing the specific page and line number of the waste group-specific work plan and/or RI report, or reproduce work plan (or RI report) text or modified text into the closure plan. Should information from waste group-specific work plans be outdated or require modification, new text will be added to the closure plan.
  - Include Closure Performance Standards.
  - Include the Closure Strategy and general Closure Activities. Sufficient detail will be included in these discussions to comply with closure plan content requirements. Should remedial design activities require changes to this information that constitute a Class 1, 2, or 3 change to the Permit, a Permit modification will be requested.
  - Include a general post-closure plan (if modified or landfill closure options will be used), with an acknowledgement that this will be updated as necessary (using appropriate public involvement) after the completion of closure. For example, the detailed requirements for post-closure groundwater monitoring may be determined after the final condition of the TSD is determined.
  - Include a commitment to prepare a verification SAP as part of remedial design.

[11] As described in Section 1.0, groundwater remediation is not within the scope of this Implementation Plan; groundwater is being addressed as separately because of the difficulty in distinguishing the specific waste units that contributed to groundwater contamination and the efficiency gained in addressing the groundwater as a whole, rather than addressing individual plumes of contamination that overlap. If a TSD contributed to groundwater contamination and that contamination has not yet been addressed as part of the overall groundwater remediation, the TSD cannot be clean closed, even if wastes and soils have been remediated. In that case, the TSD will be closed under modified closure/post-closure requirements until groundwater remediation is complete.

- To satisfy RCRA corrective action requirements, a chapter will be added that presents a recommendation for corrective action alternatives for regulatory agency consideration. Similarly, the closure plan only identifies the closure strategy that the responsible agency deemed appropriate after conducting its evaluation; there is no requirement to discuss the other closure alternatives. Therefore, to integrate this phase, the document will be developed to meet the RCRA CMS specifications and the applicable closure plans will be included.

However, should it be determined to be more effective (e.g., because of an imminent threat associated with the TSD, milestone commitments), the TSD unit closure plan may be submitted separately from the FS.

Other key features of the FS/closure plan will include the following:

- ARARs will be identified in the FS/closure plan, and ability to comply with the substantive ARARs will be an evaluation criterion for all TSD, RPP, and CPP sites. A key ARAR for developing nonradioactive constituent cleanup levels at all CPP, RPP, and TSD units will be MTCA (WAC 173-340), which is the state's performance standard for both TSD closure and RCRA corrective action and which is an ARAR at Hanford for cleanup under the CERCLA program. A key TBC material for developing radioactive constituent cleanup levels will be EPA guidance supporting a cleanup level of 15 mrem/yr.

- The CERCLA permitting exemption for onsite activities will be extended to CPP, RPP, and TSD units (e.g., air permits will not be required) except that RPP and TSD units will be incorporated into the Hanford Facility RCRA Permit.

- Remedial action objectives will consider future land use and will address protection from direct exposure to contaminants, protection of groundwater from migrating contaminants, and protection of the Columbia River.

- NEPA values such as cumulative, off-site, ecological, socioeconomic impacts, and environmental justice will be evaluated for each remedial alternative.

2.4.3 Decision-Making

TSD Closure. Under the strategy developed for the Hanford Facility RCRA Permit, TSD units that are not already in the Permit and that will not actively operate in the future are added as units undergoing closure via the permit modification process. This consists of preparing a draft permit modification, seeking public comment, and making a final permit modification pursuant to WAC 173-303-830 and -840.

At Hanford, a permit modification adding a closure plan is typically initiated by Ecology. The draft permit modification identifies permit conditions applicable to the closure and is based on the closure plan. The draft permit modification, together with the closure plan, are provide for public comment and review. The TSD closure schedule must be submitted as part of the closure plan or the TSD unit must complete closure within 180 days. Information regarding the permit modification request is sent to the Hanford mailing list and appropriate units of state and local government, and must be published in a major local newspaper. In addition, the notices and request must be placed in a location accessible to the public, and a public hearing must be held within the public comment period. Public notice of the hearing must be provided at least 30 days prior to the hearing. The comment period is 45 days.

Following the public comment period, the decision regarding the TSD closure is conveyed by Ecology in an approved permit modification. Ecology considers and responds to all significant written comments from the public on the modification request, and either grants or denies approval of the modification. Approved modification requests are incorporated into the Hanford Facility RCRA Permit and become effective 30 days after the permit modification is issued.

RCRA Corrective Action. As with a TSD closure, under RCRA corrective action the decision-making process consists of preparing a draft RCRA permit modification seeking public comment, and making a final RCRA permit modification. The recommended corrective measure(s) is presented as a draft modification to the Hanford Facility RCRA Permit and is based on the results of the CMS. The permit modification identifies specific corrective action activities and a schedule for implementation. The public comment period and hearing process and Ecology approval process are the same as for a permit modification to add a TSD unit undergoing closure. The CMS is made available to the public during the comment period, providing support to the permit modification request.

CERCLA. Under CERCLA, the decision-making process consists of a proposed plan and a ROD. Based on the evaluation of alternatives in the FS and in accordance with the Tri-Party Agreement, the DOE and the lead regulatory agency, in consultation with the supporting regulatory agency, select a proposed alternative and present it for public review and comment in a document called a proposed plan. The proposed plan provides a brief summary of all of the alternatives studied in the FS, highlighting how the alternatives satisfy the CERCLA criteria and the key factors that led to the identification of the proposed alternative. Under CERCLA, the required comment period is 30 days. Because the CERCLA process is also used at Hanford to satisfy NEPA requirements, the required comment period for proposed plans at Hanford is 45 days. The FS is made available to the public during the review, providing support to the information in the proposed plan. The DOE and the lead regulatory agency may modify the proposed alternative after reviewing public comments and/or concerns.

After the public comment period on the proposed plan has closed, the ROD is prepared by the lead regulatory agency. The ROD describes the decision-making process for selecting the cleanup action, summarizes the alternatives developed and evaluated in accordance with CERCLA and the NCP, and identifies the selected cleanup action(s). It also provides any statutory determinations such as identification of ARARs for the cleanup. The lead regulatory agency is responsible for reviewing the public comments received and preparing responses that will accompany the ROD. Although all of the CERCLA processes up through drafting the ROD are the responsibility of the lead regulatory agency, which may be Ecology on Ecology-lead operable units, the ROD must be signed by the EPA. The lead regulatory agency will continue its role after issuance of the ROD.

The ROD may be modified after it is issued. The process for modification depends on the magnitude of the change. Changes that result in no significant difference in the cleanup (e.g., correcting typographical errors) can be documented in the administrative record. A change that results in a significant impact on the cleanup requires preparation of an Explanation of Significant Differences (ESD). An ESD may be appropriate, for example, when new information is generated during the remedial design or remedial action phases that could affect the scope, performance, or cost of the remedy presented in the ROD. The public must be notified of an ESD and be provided an opportunity to review it. The ESD, however, represents only a notice of change and is not a formal opportunity for public comment because the overall remedy is not being reconsidered. When new information becomes available after a ROD is signed and results in fundamental changes to the selected remedy, an amendment to the ROD is required. Fundamental changes include selection of a new remedy that is fundamentally different than the remedy selected in the ROD. A ROD amendment must be preceded by a proposed plan that is submitted to the public for review and comment.

Integration Process for Decision-Making. The decision-making process for the 200 Area waste sites will be based on the use of waste group-specific proposed plans and RODs. Once the FS/closure plan has been finalized, a single document, the group-specific proposed plan, will be prepared that will:

- Identify the preferred alternative(s) for remediation of waste sites in that group based on the FS, and how that alternative satisfies the CERCLA criteria
- Identify criteria by which sites not in the original waste group can plug in to the remedy for that waste group (see Section 2.5.3 for further discussion of the "plug-in" approach)
- Identify, as part of the preferred alternative, criteria by which analogous sites within the waste group will be evaluated post-ROD to verify that they meet the conceptual model for the waste group, and identify a process where sites can be moved to another waste group (see Section 2.5.2 for further discussion of contingent remedies)
- Identify performance standards and ARARs applicable to the waste group
- When the operable unit includes TSD or RPP units, include a draft permit modification with unit-specific permit conditions for incorporation of those units into the RCRA permit.

After approval by the regulatory agencies, the proposed plan will be presented to the public for review and comment. The public comment period will be 45 days. A combined public meeting/public hearing will be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment. The combined meeting will avoid the confusion of two meetings and allow the public to obtain a complete picture of cleanup activities in the waste group.

After the public comment period ends, the lead regulatory agency will respond to the comments and, in consultation with the supporting agency and the DOE, make a final decision on the proposed action. The CERCLA ROD will be used to document not only the selected remedy for the CPP sites, but also the TSD unit closure strategy and the RPP corrective action decisions. The ROD will also identify the criteria for evaluating waste sites against the waste group conceptual model, the contingency process for moving waste sites to other waste groups, and criteria by which a waste site not originally in the waste group can plug-in to the selected remedy for the group. In addition, the ROD will identify ARARs for the action (and ARAR waivers for any non-TSD sites in the group) and statutory determinations (such as the availability of ERDF for all wastes generated). The RCRA permit will subsequently be modified by Ecology to incorporate the ROD (and any subsequent amendments) by reference, authorizing the RCRA actions. Specific elements incorporated by reference will include performance standards, cleanup schedules, and the selected cleanup action.

2.4.4 Implementation

TSD Closure. TSD closure proceeds in accordance with the activities identified in the closure plan and the permit conditions. No additional documentation is required during implementation of the closure activity, except that permits (e.g., air emissions permits) must be obtained as appropriate. The DOE must notify Ecology at least 60 days before beginning closure activities at a surface impoundment, waste pile, land treatment, or landfill TSD unit, and at least 45 days before beginning closure at other TSD units. Under the Hanford Facility RCRA Permit, upon initiation of closure activities, closure must be completed within 180 days unless an approved alternate schedule was included in the closure plan.

Waste generated during closure is subject to all applicable laws and regulations relative to waste management. For example, dangerous waste must be disposed at an RCRA-permitted facility (e.g., a permitted TSD unit) and solid waste must be disposed at a solid waste landfill. An exception is that, at Hanford, the Tri-Parties have determined that TSD closure waste is eligible for disposal at the ERDF under certain conditions. To be disposed at ERDF, the waste must meet ERDF waste acceptance criteria and a CERCLA decision documents (e.g., CERCLA ROD or Action Memorandum) must be in place such that waste disposal is conducted under CERCLA authority (EPA et al. 1996)[12].

RCRA Corrective Action. RCRA corrective action is implemented in accordance with the requirements and schedule specified in the permit modification. In accordance with the Tri-Party Agreement, implementation of corrective action at RPP units is guided by a corrective measures implementation (CMI) work plan and a corrective measures design report. The Tri-Party Agreement specifies that at Hanford the content of the CMI work plan will be functionally equivalent to the CERCLA remedial action (RA) work plan (described below).

Management of corrective action wastes is similar to TSD closure wastes except that under state regulations, RCRA corrective action waste that is designated as dangerous waste can be managed at a corrective action management unit (CAMU). A CAMU is an area within a facility that is designated by Ecology for the management of RCRA corrective action waste (WAC 173-303-646[5] and [6]). No CAMUs have been designated at the Hanford Site.

CERCLA. Under CERCLA, cleanup is implemented via a remedial design (RD) report (RDR) and a RA work plan (RAWP). The RD is an engineering phase during which technical drawings, specifications, construction budget estimates, and preparation of all necessary and supporting documents are developed for the chosen cleanup action. These items are based on the selected remedy, performance standards, ARARs, and other requirements specified in the ROD and are documented in the RDR. The RDR is provided to the lead regulatory agency for review and approval. A verification SAP is prepared along with the RDR for use after remedial action is complete.

The RA includes the actual construction or implementation of the cleanup action. The RA includes construction of any support facilities as specified in the RD. A RAWP is developed for each operable unit detailing the plans for the RA. The RAWP is provided to the regulatory agency for review and approval. At Hanford, the RDR and RAWP often are combined into a single report. Included in either the RD or RA are the verification SAPs describing the requirements for sampling and analysis for samples taken for the purpose of determining whether the cleanup action levels specified in the ROD have been achieved. Substantial continuous onsite remedial action at an NPL-listed federal facility must begin within 15 months after the first ROD for that facility is signed. The 200 Areas is one of four such facilities at the Hanford Site listed on the NPL. The progress of remedial action is typically defined in a schedule included in the RDR.

Contaminated waste generated during CERCLA cleanup actions must be disposed at an EPA-approved onsite and/or offsite facility. Onsite facilities must comply with the action-specific ARARs (e.g., RCRA standards) for waste management including those that establish controls and/or restrictions for waste disposal. At the Hanford Site, the ERDF is the approved CERCLA waste disposal facility. The

[12] *The U.S. Department of Energy Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington-Explanation of Significant Differences* (ESD) (EPA et al. 1996) modified the ERDF ROD (EPA et al. 1995) to clarify the eligibility of waste generated during cleanup of the Hanford Site. The ESD makes eligible for disposal at ERDF any environmental cleanup waste generated as a result of CERCLA or RCRA cleanup actions provided it meets ERDF waste acceptance criteria and that the appropriate CERCLA decision documents are in place. Additionally, the ESD allows the disposal at ERDF of nonprocess wastes generated from closure of inactive RCRA TSD units provided that (1) closure wastes are sufficiently similar to CERCLA or RPP wastes placed in ERDF, (2) the ERDF waste acceptance criteria are satisfied, and (3) the appropriate CERCLA decision documents are in place.

construction and operation of ERDF was authorized via a separate ROD as issued January 1995 and amended December 1997 (EPA et al. 1995, EPA et al. 1996).

Integrated Process for Implementation. Implementation will consist of confirmatory sampling and preparation and implementation of an RDR/RAWP. A verification SAP will be prepared that will define the characterization requirements for confirming whether sites within a waste group that were not characterized as representative sites meet the conceptual model for the waste group. Sampling, analysis, and evaluation will be performed before the RDR/RAWP is completed. If confirmatory sampling does not support a site in a given waste group, the contingency element of the ROD will be implemented and the site will be moved to another waste group.

An RDR/RAWP will be prepared for each waste group that encompasses implementation of the selected remedy for CPP, RPP, and TSD units. The RDR/RAWP will be formatted as described under the CERCLA program. It may be phased to accommodate the award of construction packages for the remedial action. If phased, the general requirements for the RD/RA would be documented in the initial issue of the RDR/RAWP. Design details for individual waste sites would be added in progressive revisions until all waste sites were addressed. The RDR/RAWP will be submitted to the lead regulatory agency for review and approval.

The RDR/RAWP will be accompanied by a verification SAP for each waste group for verification sampling and analysis. This SAP will define the requirements for verifying that remedial action at a site has met the requirements of the ROD. A DQO process will be used to determine sampling and analytical needs.

The RDR/RAWP will include a schedule for remediation activities for the waste group, including the schedule for TSD closure. Integration of the remedial action/closure schedules for CPP, RPP, and TSD will provide for efficiencies and cost-savings in mobilizing equipment and conducting field activities. Per CERCLA requirements, continuous onsite remedial action must begin within 15 months of the issuance of the first ROD for the 200 Area CERCLA facility. DOE will provide notice to Ecology 60 days before beginning closure of any TSD units in a waste group.

Contaminated materials generated during the remedial action will be disposed at the ERDF provided the elements of the ERDF waste acceptance criteria are satisfied.

2.4.5 Closeout

TSD Closure. Within 60 days of completion of closure of a TSD unit, the owner or operator must submit a certification of closure to Ecology (WAC 173-303-610(6), RCRA Permit II.J.1). The certification must be signed by the owner and an independent registered professional engineer. Documentation that the closure has been in accordance with the approved closure plan must accompany the certification. The documentation is usually in the form of a closure activities evaluation report or a verification package, which evaluates the closure activities and compares them to the regulatory and closure plan requirements. Additional notifications that must be made after certification of closure are the submission of survey plats and notices in deed to the zoning authority.

If the closure is a clean-closure, Ecology then initiates a permit modification to acknowledge that the unit has been clean-closed and initiates withdrawal of the unit from the EPA national database for TSD units. These requirements are detailed in WAC 173-303-610.

If dangerous constituents will remain onsite above clean closure standards, a post-closure plan will have been prepared as part of the closure plan and will be implemented at this time. The post-closure plan will be reviewed in light of any new information generated during remediation to ensure that it is still protective of the TSD unit and groundwater. If any modification of the post-closure plan is necessary, a permit modification will be completed prior to implementation. When the need for post-closure care ends, a certification of completion of post-closure care is submitted to Ecology using the same process as described for certification of closure. As with clean-closure, Ecology will then initiate a permit modification and withdrawal of the unit from the national database.

RCRA Corrective Action. State regulations do not define a closeout process for corrective action units. The Tri-Party Agreement states that upon satisfactory completion of the CMI phase, the lead regulatory agency will issue a certificate of completion of the corrective action.

CERCLA. Remedial action is considered complete when the lead regulatory agency determines that the following have been met:

- Remedy is fully operational and performing to design specifications
- Remaining activities only involve operation and maintenance (O&M).

At this time, the DOE completes a Superfund Site Closeout Report. A facility is eligible for NPL deletion when the EPA has determined that all required response actions (with the exception of O&M) have been implemented. (Partial deletion is possible where only that portion of a CERCLA facility that has been remediated is deleted.) The site shall not be deleted from the NPL until the state in which the site is located has concurred on the proposed deletion. The EPA shall provide the state 30 working days for review of the deletion notice prior to its publication in the *Federal Register*. Once the state agrees with the deletion notice, the EPA publishes a notice of intent to delete in the *Federal Register* and seeks public comment for a minimum of 30 calendar days. Copies of the proposed deletion notice are placed in the local repositories available for public viewing. After the public comment period, the EPA shall respond to significant comments and include this response document in the final deletion package. Once the notice of final deletion has been published in the *Federal Register*, the site(s) are deleted from the NPL and the package is placed in the local information repositories.

An O&M plan is initiated at each operable unit when remedial action implementation has been completed and it is determined that the remedy is to be fully operational. The O&M plan includes inspections and monitoring. The O&M plan is provided to the lead regulatory agency for review and approval. When waste is left in place as part of the RA, O&M is expected to be a long-term activity. In cases where all waste is removed or treated, a short O&M period still may be specified by the lead regulatory agency. The lead regulatory agency may, where appropriate, allow for O&M to be discontinued for certain units, within an operable unit, while requiring O&M to continue at other units.

When waste is left in place at the completion of remedial action, the operable unit will be evaluated by the lead regulatory agency at least every 5 years (CERCLA Part 121[c]) to determine whether the remedy continues to be protective or further RA is required. In accordance with the Tri-Party Agreement, the lead regulatory agency will issue a Certificate of Completion to the DOE when the remedial action work is completed.

Integrated Process for Closeout. The closeout process to be followed for each waste site will consist of preparing a closure certification (for TSD units), a site- or group-specific site closeout report and, as appropriate, O&M plan; deletion from the NPL; and removal from the permit.

The site closeout report will summarize the cleanup activities conducted at any CPP, RPP, or TSD units in the waste group, present the results of verification sampling, and compare those results to the remediation goals specified in the ROD. If contaminants are left in place above the remediation goals, the report will specify the nature and extent of that contamination. The site closeout report will be submitted to the lead regulatory agency for review and approval. When the lead agency has determined that there has been satisfactory completion of remedial action activities, the agency will issue a certificate of completion. At that time, Ecology will initiate a permit modification for RPP units to acknowledge that corrective action activities have been completed.

Within 60 days of completing closure activities at any TSD unit within the waste group, DOE will submit a certification of closure for the TSD signed by an independent registered professional engineer. The site closeout report may be used as supporting documentation. Ecology then will initiate a permit modification whereby the permit will be changed either to acknowledge clean closure of the unit or to implement the post-closure plan, whichever is applicable.

If contaminants are left onsite above protective levels, an O&M plan will be prepared. The O&M plan will detail post-remediation operation, inspection, and/or monitoring necessary, including groundwater monitoring, for affected CPP, RPP, and TSD units. If the waste group contains a TSD unit that was not clean closed, the RCRA TSD unit post-closure plan will be reviewed to ensure consistency with closure results and the O&M plan. (The TSD unit post-closure plan is prepared and submitted at the same time as the closure plan.) Changes to the post-closure plan will be documented via a RCRA permit modification. If the post-closure plan requires significant modification, it will be submitted for public review. The group-specific O&M plan will not be submitted for public review. If O&M is required for RPP units, a RCRA permit modification also will be done for those units to incorporate by reference the O&M plan.

Upon completion of the remedial action (not including O&M), the waste site/group can be deleted from the NPL. The EPA will prepare a deletion notice and provide it to the state 30 working days prior to its publication in the *Federal Register*. Once the state agrees with the deletion notice, EPA will publish a notice of intent to delete in the *Federal Register* and seek public comment for a minimum of 30 calendar days. Copies of the proposed deletion notice will be placed in the Hanford regional repositories available for public viewing. After the public comment period, the EPA shall respond to significant comments and include this response document in the final deletion package. Once the notice of final deletion has been published in the *Federal Register*, the site(s) will be deleted from the NPL and the package will be placed in the local information repositories.

Although CERCLA allows facilities or portions of facilities to be deleted from the NPL while contaminants remain onsite undergoing O&M, RCRA does not have a similar provision. TSD and corrective action units will remain under the RCRA permit as long as post-closure or O&M continues. Therefore, if contaminants remain onsite above cleanup levels, sites might be deleted from the NPL but remain in the Hanford Facility RCRA Permit. A certification will be prepared by DOE for review by the regulatory agency upon completion of all activities required in the post-closure plan (for TSD units) or O&M plan (for RPP units). Upon acceptance by Ecology of the certification, Ecology will prepare a permit modification to delete the unit(s) from the permit.

2.4.6 Short-Term Action

TSD Closure. There are no specific provisions for interim action as part of TSD closure. State regulations and the Tri-Party Agreement defer to the corrective action program in the event that a release from a TSD is detected.

RCRA Corrective Action. A short-term response called an interim measure may be implemented under RCRA to provide immediate response for sites that pose an immediate threat to public health or the environment. This process is defined in the Section 7.2.4 of the Tri-Party Agreement. Interim measures are used when information indicates that an expedited response is needed because of an actual or threatened release from a past practice unit. The lead regulatory agency may require RL to submit a proposal for an expedited response at a unit, or the RL may voluntarily submit a proposal. The interim measure process will be used in cases where early remediation will prevent the potential for an imminent and substantial endangerment or imminent hazard to develop. It may also be used in cases where a single unit within an operable unit is a high priority for action, but the overall priority for the operable unit is low. In this way, a specific unit or release at an operable unit can be addressed on an expedited schedule when warranted. To the extent practicable, interim measures shall be consistent with the anticipated alternatives for final selection of corrective measures at the unit.

All interim measures are first approved by the lead regulatory agency. Public participation and documentation for interim measures are in accordance with Sections 9.0 and 10.0 of the Tri-Party Agreement or the RCRA permit modification process.

CERCLA. The process used under CERCLA to address sites that present an imminent and substantial danger to the public health or the environment is the removal action process (40 CFR 300.415). Removal actions can occur at a site not listed on the NPL, or they can occur as part of the initial response to seriously contaminated NPL sites that will become the subject of a more formal and extensive remedial action. The EPA has categorized removal actions in three ways: emergency, time-critical, and non-time-critical. These categories are based on the type of situation, the urgency and threat of release, and the subsequent time frame in which the action must be initiated. Emergency and time-critical removal actions respond to the releases requiring action within 6 months; non-time-critical actions respond to releases requiring action that can start later than 6 months after it has been determined that a response is warranted.

In carrying out emergency and time-critical removal actions, the federal agency implementing CERCLA removal action authority allows work to begin as soon as possible to abate, prevent, minimize, stabilize, mitigate, or eliminate the threat to the public health or the environment. Because these are considered emergency actions, public involvement is not required prior to performing the action. However, during or after the removal action the public must be informed of the action being taken. If the removal action is determined to be non-time-critical, an engineering evaluation/cost analysis (EE/CA) is performed. The goals of the EE/CA are to identify the objectives of the removal action and to analyze the various alternatives that may be used to satisfy objectives for cost, effectiveness, and implementability. While an EE/CA is similar to the RI/FS conducted for RAs, it is less comprehensive. Like the RA process, the EE/CA is provided to the public for review and comment. After the comment period, the implementing agency prepares the decision document called an Action Memorandum. The Action Memorandum documents the selected removal action and provides the approval to begin the work activities.

Integrated Process for Interim Action. In the event that it is discovered during the field investigation or remedy implementation that a site or contamination source presents a threat to the public health or the environment, a CERCLA removal action will be initiated. Action will be taken as soon as possible to abate, prevent, minimize, stabilize, mitigate, or eliminate the threat to the public or the environment. Depending on the criticality of the situation, during or after the removal action, an EE/CA will be performed and an action memorandum pursued.

2.5 STREAMLINING APPROACHES

This section presents various strategies that are available for streamlining the regulatory pathway and documentation requirements when addressing Hanford waste sites. Implementation of these strategies on previous cleanup projects at the Hanford Site indicates that their use results in efficient use of resources, both human and financial, allows for earlier selection of a remedial alternative, and allows actual waste site cleanup to be performed in an expedited manner. Opportunities for streamlining exist during both characterization and assessment, in the selection of the type of decision document, and during remedial design and remedial action. The following discussion summarizes the streamlining strategies and impacts during each of these phases.

2.5.1 Analogous Site Concept

Facilities can sometimes have many source sites that are geologically similar and have similar process and waste disposal histories. In these situations, the analogous site concept can be used to reduce the amount of site characterization and evaluation required to support remedial action decision making. For the analogous site approach, waste sites are combined into groups of sites with similar location, geology, waste site history, contaminants, etc. Within each group, one or more representative sites are then selected for comprehensive field investigations, including sampling. Findings from site investigations at representative sites are extended to apply to other sites in the waste group that were not characterized. Sites for which field data have not been collected are assumed to have similar or "analogous" chemical characteristics to the site(s) that were characterized. Confirmatory investigations of limited scope can be performed at the sites not selected as representative sites, rather than full characterization efforts.

The evaluation of remedial alternatives focuses on the representative sites but is acknowledged to extend to other sites in the group. A remedy is selected for all of the sites in the group, based on the evaluation of the representative sites. Confirmation sampling of the analogous sites after remedy selection may be required and is built into the remedial design planning to demonstrate that analogous conditions exist. Depending on the level of confidence in the analogous site classification, a contingent ROD may be beneficial to address those instances where it is determined during confirmation sampling that a site is not analogous (see Section 2.5.2). Although the analogous site concept introduces a degree of uncertainty, there is a substantial benefit in the early selection of a remedy that allows early cleanup action to take place.

The 200 Areas Strategy and this Implementation Plan build on the analogous site concept. As part of the initial strategy, the waste sites in the 200 Areas were organized into waste groups based on similar processes, waste disposal histories, and type of site. Representative sites have been identified within each group (DOE-RL 1997). The waste groups are discussed further in Section 3.0. Section 6.0 reflects a characterization effort that focuses on the representative sites, and the RI and FS reports will be written based on information regarding these representative sites. A proposed plan and ROD will be written for the entire waste group, identifying the proposed remedy for sites in that group. The ROD will include criteria for post-ROD confirmation sampling and analysis to be used to verify that all remaining sites in the group (sites other than the representative sites) meet the conceptual model for the waste group. If a waste site fails to meet the conceptual model such that the selected remedy is not appropriate, it will be removed from the group and reassigned to another waste group. If a contingent ROD is prepared that clearly defines criteria for removing a waste site from the original waste group, modification of the ROD may not be required. If the group to which the site would be moved already has a ROD, modification of that ROD or development of a new ROD may be required.

2.5.2 Contingent Remedy

In general, the CERCLA proposed plan identifies a preferred alternative and the lead regulatory agency selects a single remedy in the ROD. There are some situations, however, where greater flexibility may be required to ensure implementation of the most appropriate remedy for the site. This is the case where there is significant uncertainty associated with the remedy selection. In such situations, a contingent remedy may accompany the selected remedy in a decision document. The contingent remedy would be available if the selected remedy was determined to be inappropriate for a waste site.

In the proposed plan, the alternative proposed for selection and the contingent alternative should both be discussed in the Preferred Alternative section. Also, the criteria that would prompt implementation of the contingent remedy should be clearly identified. In the ROD, the Comparative Analysis of Alternatives section should discuss both alternatives and the Selected Remedy section should establish the parameters of each and provide criteria by which the contingent remedy would be implemented.

A potential application in the 200 Areas would be to address the uncertainty inherent in the analogous site approach. A potential disadvantage of the analogous site approach is that a site that is thought originally to fit into one waste group may be determined during post-ROD verification sampling not to be analogous to sites in that group. A contingent ROD could be used to specify what happens to such a site. For the 200 Areas, it is envisioned that the site would be removed from that waste group and reassigned to another, more appropriate waste group. The criteria for making this determination and reassignment could be specified as the contingent remedy in the proposed plan and ROD. The application of the Contingent ROD approach to a waste group will be determined by the regulating agencies on a case-by-case basis for the waste group to which it will be applied. The determination of whether its use will require the development of a new ROD, amended ROD, and/or an Explanation of Significant Difference for implementation or whether it can be applied without a new or modified ROD will also be made by the regulating agencies.

2.5.3 Plug-In Approach

Traditional CERCLA and RCRA corrective action cleanup methodology dictates that individual waste sites be clearly identified during characterization, evaluation, and public involvement. Remedy selection for these specific sites is then documented in the decision document. Because of the large number of generally similar, yet individual waste sites at some facilities, such as Hanford, such an approach can result in many redundant characterization, evaluation, and remedy selection documents with attendant schedule and budget impacts. For example, the analogous site approach discussed in Section 2.5.1 streamlines the characterization and evaluation phases, but ultimately all of the waste sites within a waste group will be specifically listed in the proposed plan and ROD. A newly identified site that fits the general profile of the waste group could not be covered by the ROD because it was not specifically identified in the ROD. At a minimum, a new proposed plan, and possibly a new ROD, would be required.

For facilities such as these, the need for a streamlined, consolidated approach led to the development of the "plug-in approach." The plug-in approach specifies and analyzes remedial alternatives for a group of sites that have similar characteristics (e.g., physical attributes, contaminants, and contaminated media) designated as the "site profile." A ROD is issued with a remedy selected based on the site profile. If it is determined that a new individual site is sufficiently similar to, or compatible with, a site group for which the alternatives have already been developed and analyzed, the subject site is said to "plug-in" to the analysis for that group. Confirmation sampling of the site might be required to determine whether it fits the criteria for plug-in. Confirmation sampling of sites for plug-in must be approved by the lead agency in the ROD and remedial design. Thus, remedy selection for a large number of sites can be accomplished expeditiously and in a cost-effective manner using the plug-in approach to eliminate the time and cost required to produce multiple, redundant site-specific FSs.

The effective use of the plug-in approach requires a plug-in ROD. A plug-in ROD specifies the criteria that a specific waste site must meet in order to "plug-in" to the process and be remediated in accordance with the remedy selected in the ROD. The plug-in ROD also describes the process for determining whether conditions at a particular site are consistent with the plug-in criteria. Under this approach, a remedy is selected that applies to similar conditions (site profile), rather than to specific sites. Many waste sites can be incorporated into a plug-in ROD following a demonstration that site conditions conform to the site profile. A single plug-in ROD, therefore, can replace many waste site-specific RODs that would otherwise be required but would ultimately be redundant.

The plug-in approach can be combined with the analogous site and contingent ROD approaches to provide a comprehensive and streamlined approach for 200 Area remediation. A ROD prepared for a given waste group would identify the selected remedy for that waste group and criteria by which a site that was not originally part of that waste group could plug-in to the waste group. The following example illustrates how the approaches work together:

> Waste site X is originally assigned to waste group A, and a ROD is obtained for waste group A. During post-ROD confirmation sampling, it is determined that X does not fit the conceptual model for waste group A but is analogous to waste group B, which already has a ROD. ROD A has a contingent remedy that specifies that waste sites can be reassigned if they do not meet the conceptual model for waste group A. ROD B contains criteria for when a site can plug-in to ROD B. Waste site X could thus be moved from ROD A to ROD B without additional remedy selection documentation. Information regarding this reassignment would be placed in the administrative record.

A plug-in approach allows implementation of remedial actions at multiple waste sites without expending resources to initially characterize similar sites before a ROD is issued. By use of a plug-in approach, remediation can begin earlier with considerable cost savings through reduction in documentation and focused characterization. The application of the Plug-in Approach to a waste group will be determined by the regulating agencies on a case-by-case basis for the waste group to which it will be applied. The determination of whether its use will require the development of a new ROD, amended ROD, and/or an Explanation of Significant Difference for implementation or whether it can be applied without a new or modified ROD will also be made by the regulating agencies.

The EPA has recognized certain categories of waste sites across the country that have many common characteristics (e.g., contaminants present, past waste disposal practices) that are suited to cleanup using a prescribed or "presumptive" cleanup remedy. This recognition stems from the results of detailed evaluations of many of the sites. The presumptive remedy approach for remedy selection at a particular type of site also recognizes that remediation of some types of waste sites by use of other remediation options is impractical or cost prohibitive. The presumptive remedy ROD, therefore, selects a response action that the EPA has prescribed for that particular type of site. An example is the use of containment as a presumptive remedy for municipal landfills. A presumptive remedy ROD can be obtained for those types of sites that the EPA has prescribed presumptive remedies, after a particular site has been shown to conform to characteristics of those sites for which the presumptive remedy is applicable. Use of the presumptive remedy process in obtaining a ROD can simplify the evaluation of alternatives in the assessment and streamline the remedy selection process considerably. Focus packages will not be used exclusively to make decisions regarding cleanup actions at 200 Area waste groups. The information may be used to support the development of more streamlined documentation required under the CERCLA process, such as feasibility studies, proposed plans, RODs, or modifications to RODs, such as ESDs.

None of the waste sites in the 200 Area fit the profiles for presumptive remedies issued by the EPA to date. However, the plug-in approach described above is built on concepts similar to the presumptive remedy approach.

2.5.4 Focus Package

Focus packages are used to streamline the characterization and assessment process. Focus packages are used when it is determined that there is a minimal need for remediation or that remedial action would follow a path similar to that already followed at similar waste sites. The focus package explains why additional evaluation/analysis and documentation of remedial alternatives is not required, provides the site-specific information need to complete the remedy selection process, and supports the issuance of a proposed plan followed by a new ROD or modification of an existing ROD.

Under the 200 Areas Strategy, a focus package may be appropriate when it is determined that a waste site does not fit the conceptual model for its assigned waste group but does fit the conceptual model for another group for which a ROD has already been issued. The information collected during confirmation sampling could be used to prepare a focus package supporting modification of the ROD for the other waste group.

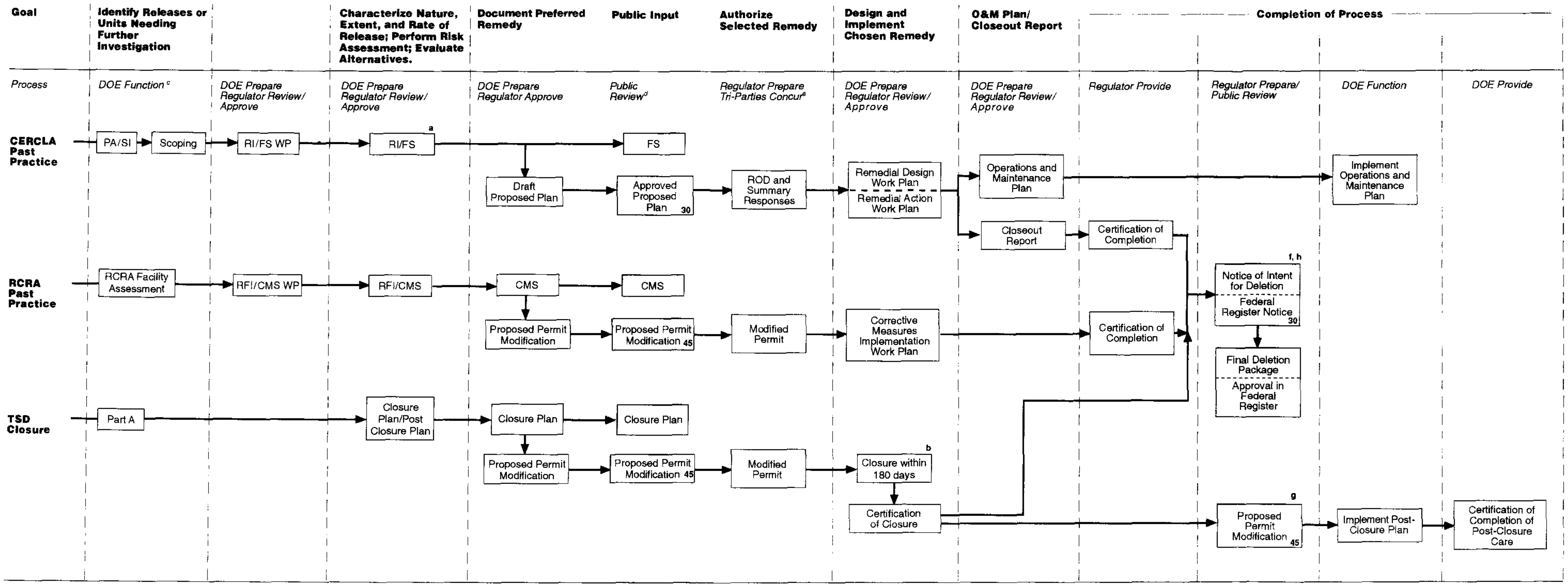
2.5.5 Observational Approach

The "observational approach" is a method of planning, designing, and implementing a remedial action that uses a limited amount of initial field characterization data (e.g., from the analogous site concept) to create a general understanding of site conditions. Additional information gathered during remedial actions is used to make "real time" decisions in the field to guide the direction and scope of remedial actions, based on contingency planning performed before mobilization into the field. The observational approach requires effort during the remedial design planning to identify uncertainties that might be encountered in the field and develop contingency plans for dealing with a range of conditions that might be encountered. The contingency plans are typically documented in the RD/RA work plans.

When initiating remedial actions under this set of conditions, it is recognized that unforeseen conditions may be found that require additional remedial actions to be undertaken. If conditions are found to be sufficiently different than had been expected and a modification to the cleanup remedy is required or a different cleanup approach is required, this change can be implemented by use of an ESD or a ROD amendment. Alternatively, remedial actions may determine that levels of contaminants are significantly below what had been expected, and that further remedial actions are not necessary. The observational approach in cleanup actions provides the flexibility in the field necessary to adapt to actual site conditions encountered during remedial actions by scaling the level of effort to conditions encountered. Remediation proceeds until it can be demonstrated through a combination of field screening and verification sampling that cleanup goals have been achieved.

Thus, the observational approach is a "learn as we go" methodology. This method of streamlining is considered to be more cost- and time-effective than traditional approaches that require substantial amounts of initial characterization data to make very detailed plans and engineering designs before initiating remedial actions.

Figure 2-1. Typical Regulatory Processes at the Hanford Site for CERCLA, RCRA Past Practice and RCRA TSD Closure.



TSD = treatment, storage, and disposal
PA/SI = preliminary assessment/site investigation
RI/FS (WP) = remedial investigation/feasibility study (work plan)
RFI/CMS WP = RCRA facility investigation/corrective measure study work plan
ROD = Record of Decision
RD/RA = Remedial Design/Remedial Action
CMI = corrective measures implementation
O&M = Operations and Maintenance

30 Days for Public Review.

Public Review.

Legend:

a) Could be conducted in phases.

b) Unless otherwise stated in closure plan.

c) These steps would be applicable to newly discovered sites, however this phase has been completed at Hanford, which resulted in the 200 Area being placed on the NPL. The TPA designates operable units within the 200 Area as either CPP, RPP or TSD. A Part A permit application has been submitted for all known TSDs. Additionally, a separate Community Relations Plan has been developed that meets the requirements for having such a plan at NPL sites, and also covers all community relations needs of the TPA, including RCRA public involvement requirements.

d) During Public Review, a public meeting must be held for the Proposed Plans, and, if requested, a public hearing will be held for Permit Modifications.

e) Although it is technically the responsibility of the lead regulatory agency to prepare these documents, DOE typically collaborates with the appropriate agency to prepare the text.

f) The entire 200 Area is on the NPL. Individual sites or groups of sites may be proposed for deletion from the NPL prior to completion of cleanup and/or post-remediation care. However, all sites will have to be completed prior to removal of the 200 Area from the NPL.

g) Permit modification to either identify unit as clean-closed or modify post-closure plan; if necessary, for post-closure care.

h) EPA prepares for State Regulator 30 working-day review. After EPA announces intent in Federal Register, public review occurs for 30 days.

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Figure 2-2. 200 Areas Integrated Regulatory Process for CERCLA, RCRA Past-Practice, and RCRA TSD Unit Closure.

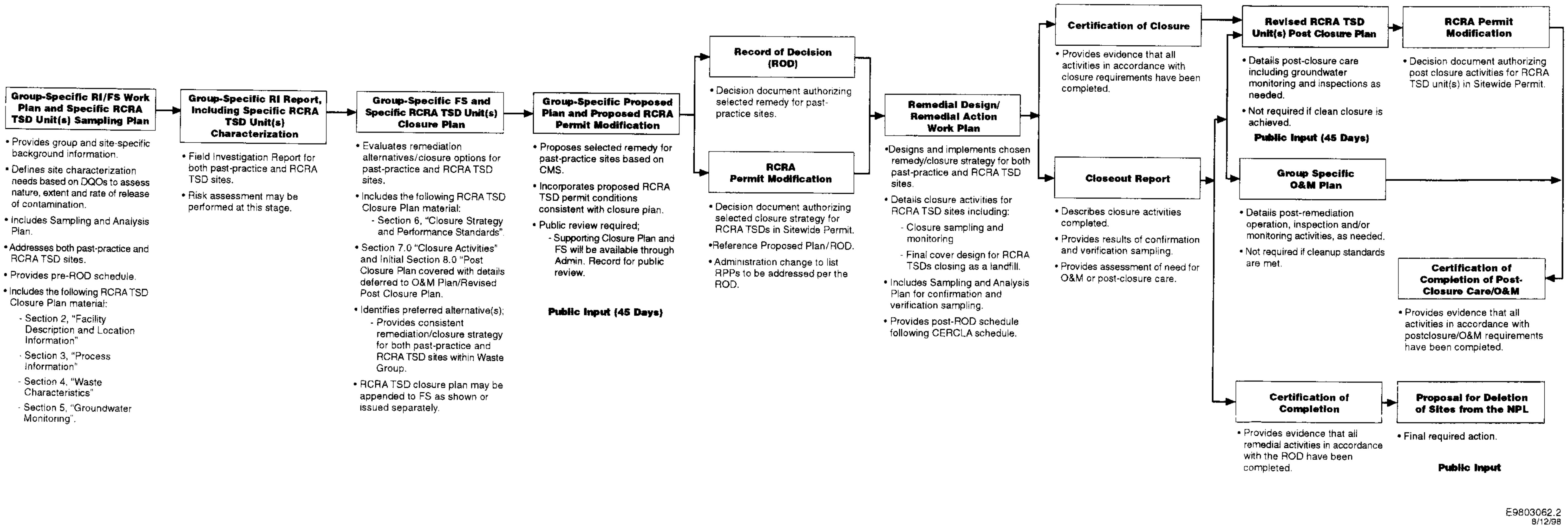


Table 2-1. Overview of the Hanford Facility[a] Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste.

The Washington State Department of Ecology issued a permit to the U.S. Department of Energy to authorize[b] the treatment, storage, and disposal of dangerous waste at the Hanford Facility. The Hanford Facility RCRA Permit consists of six major parts and a number of attachments as summarized below:	
Part I – Standard Conditions	This part provides the legal conditions of the permit such as severability and duties and requirements of the parties.
Part II – General Facility Conditions	This part provides conditions that are applicable to the entire Facility. For example, it discusses on-site transportation and waste manifesting requirements, land disposal restrictions, record keeping and reporting, etc.
Part III – Unit-Specific Conditions for Final Status Operations	This part contains individual chapters that provide the specific conditions applicable to *active* treatment, storage, and disposal units. Currently, there are six such units that have been incorporated into the permit[c].
Part IV – Correction Actions for Past Practices	This part states that the HSWA Permit is issued by the EPA in conjunction with this Permit. Upon delegation of the Corrective Action requirements of the HSWA by the EPA to Ecology, the Permit shall be modified via a Class 3 modification to incorporate the specific requirements of the HSWA Permit into this Permit. Until this modification is complete, compliance with the terms of the referenced provisions, shall be deemed as compliance with WAC 173-303-646.
Part V – Unit-Specific Conditions for Units Undergoing Closure	This part contains individual chapters that provide the specific conditions applicable to storage, treatment, and disposal units that are *undergoing closure*. Usually, the individual chapters incorporate, by reference, the closure plans of the specific units. Currently, there are 14 such units that have been incorporated into the permit, 10 of which have already been clean closed.
Part VI – Unit-Specific Conditions for Units in Post-Closure	This part contains individual chapters that provide the specific conditions applicable to storage, treatment, and disposal units that *have already been closed, but that require a post-closure care period.* Generally, land-based units that were not clean closed are subject to post-closure requirements such as groundwater sampling and monitoring. Currently, there are two such units that have been incorporated into the permit.
Attachments	There are currently 40 attachments to the Permit, most of which are the closure or post-closure plans or Part B permit applications for specific TSD units. The attachments also include the Tri-Party Agreement, which is an enforceable portion of the Permit. Other pertinent attachments include such things as the Facility Contingency Plan, Purgewater Management Plan, the Hanford Legal Description, and acceptable laboratory methods. Units are incorporated into the Permit or are moved to other parts of the Permit via the Permit modification process. There are several types of modifications that can occur, categorized by class. Typically, major modifications, such as the incorporation of a new unit into the Permit, require a Class III modification. Class III modifications require that the public be involved in the decision-making process concerning operation, closure, and/or post-closure procedures for a specific unit.

[a] For the purposes of the Permit, the Hanford Site is considered to be a single facility consisting of over 60 TSD units. Approximately 25% of the TSD units are or are anticipated to be operating, while approximately 50% are closed or are undergoing closure. The remaining TSD units are being dispositioned through other options under the Tri-Party Agreement.

[b] Authority for the permit is pursuant to Chapter 70.105 RCW, the *Hazardous Waste Management Act* of 1976, as amended, Chapter 70.105D RCW, the *Model Toxics Control Act*, and regulations promulgated thereunder by the Washington State Department of Ecology, codified in Chapter 173-303 *Washington Administrative Code*.

[c] Information presented in this box is based on Revision 4A of the Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, issued by the Washington State Department of Ecology on February 25, 1998.

Table 2-2. 200 Areas RCRA TSD Units Associated with Waste Groups.

TSD Unit	Status
200 West Area Ash Pit Demolition Site	Clean Closed 10/26/95 – In Part V of Permit
207-A South Retention Basin	Interim Status
2101-M Pond	Clean Closed 10/26/95 – In Part V of Permit
216-A-10 Crib	Interim Status
216-A-29 Ditch	Interim Status (Mod F – 2000[a])
216-A-36-B Crib	Interim Status
216-A-37-1 Crib	Interim Status
216-B-3 Expansion Ponds (216-B-3A, -3B, and –3C)	Clean Closed 6/27/95 – In Part V of Permit
216-B-3 Main Pond (216-B-3 and 216-B-3-3)	Interim Status (Mod F – 2000)
216-B-63 Trench	Interim Status (Mod F – 2000)
216-S-10 Pond and Ditch	Interim Status
216-U-12 Crib	Interim Status
218-E-8 Borrow Pit Demolition Site	Clean Closed 10/26/95 – In Part V of Permit
222-S Laboratory Complex (222-SD only) (Part B[b])	Interim Status (Mod E – 1999)
241-CX Tank System	Interim Status
241-Z Treatment and Storage Tanks	Interim Status
Double-Shell Tank System (Part B)[c]	Interim Status (Mod E – 1999)
Hexone Storage and Treatment Facility (276-S-141/142)	Interim Status
Low-Level Burial Grounds[d] (Part B)	Interim Status
Nonradioactive Dangerous Waste Landfill	Interim Status
PUREX Storage Tunnels 1 and 2 (Part B)	In Part III of Permit
Single-Shell Tank System[e]	Interim Status

[a] TSD units will be incorporated into the permit according to the annual schedule as shown through year 2000 in accordance with applicable requirements in WAC 173-303-830. All TSD units that do not have a specific year shown will be incorporated after 2000 in a schedule that is negotiated by the Tri-Parties.

[b] A Part B Permit Application has been submitted for units with (Part B) following the name.

[c] Only part of the TSD Unit, the 244-S Double-Contained Receiver Tank, is included in this Implementation Plan.

[d] This Implementation Plan includes waste sites for the Low-Level Burial Grounds as follows: 218-W-6, 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5.

[e] Only the diversion boxes within this TSD unit are included in this Implementation Plan: 240-S-151, 240-S-152, 241-B-154, 241-BX-154, 241-BX-155, 241-C-154, 241-TX-155.

3.0 200 AREAS SETTING AND BACKGROUND

This chapter summarizes data related to the physical setting (Section 3.1), site operations and waste generation (Section 3.2), and contaminant fate and transport (Section 3.3) in the 200 Areas. Detailed supporting information on the physical setting, waste sites, and chemical processes is provided in Appendices F, G, and H, respectively. The background information presented in this chapter and supporting appendices is common to all 200 Area waste sites and is included in the Implementation Plan to serve as a primary reference for the 23 group-specific work plans. Consolidating this generic information is part of the commitment to streamline production of the work plans, which will focus on the detailed, site-specific data.

Data on the physical characteristics of the 200 Areas (Section 3.1) are needed to define potential contaminant transport pathways, from the disposal sites toward groundwater and potential receptors, and to support engineering, development, and screening of remedial action alternatives. The emphasis is to identify the geological, hydrological, and meteorological parameters that control the migration of contaminants in the subsurface.

The overview of operations (Section 3.2) provides data on the sources of contaminants in the 200 Areas. Brief explanations of the site processes, operational history, waste management philosophies, and major potential contaminants used since 1943 support the identification of the types and volumes of wastes disposed to the soil column, the logic underlying the waste site grouping process, and the contents of the major potential contaminants lists.

Physical and chemical interactions between the contaminants and the soil (Section 3.3) affect the distribution of contaminants in the vadose zone. The typical expected distribution of contaminants is summarized in the preliminary physical conceptual model of contaminant distribution, which in turn supports the preliminary conceptual exposure model (Chapter 5.0).

Hanford Site Background. The Hanford Site (Figure 1-1) lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The Hanford Site, approximately 50 km (31 mi) north to south and 40 km (25 mi) east to west, encompasses approximately 1,450 km^2 (560 mi^2) north of the confluence of the Yakima and Columbia Rivers. This land, with restricted public access, provides a buffer for the smaller fenced areas currently used for storage of nuclear materials, waste storage, and waste disposal. Only about 6% of the land area has been disturbed and is actively used. The Columbia River flows eastward through the northern part of the Hanford Site and, after turning south, forms part of the Site's eastern boundary. The Yakima River runs near the southern boundary of the Hanford Site and joins the Columbia River at the city of Richland, which bounds the Hanford Site on the southeast. Rattlesnake Mountain, Yakima Ridge, and Umtanum Ridge form the southwestern and western boundaries. The Saddle Mountains form the northern boundary of the Hanford Site. Adjoining lands to the west, north, and east are principally range and agricultural land. The cities of Kennewick, Pasco, and Richland (Tri-Cities) constitute the nearest population centers and are located southeast of the Hanford Site (Neitzel 1997).

Established in 1943, the Hanford Site was originally designed, built, and operated to produce plutonium for military nuclear weapons. Uranium metal billets were received in the 300 Area and fabricated into jacketed fuel rods suitable for loading into nuclear reactors. The fuel rods were placed in the reactors in the 100 Areas and irradiated under nuclear fission reactions. The fuel rods were then taken to the 200 Areas, where plutonium and uranium were separated from the residual activation and fission products using liquid chemical processes. The 600 Area includes portions of the Hanford Site not included in the 100, 200, or 300 Areas and served primarily as transportation corridors and buffer zones between the fabrication, irradiation, and chemical processing areas. Other designated areas of the Hanford Site include the 400 Area (Fast Flux Test Facility), 700 and 3000 Areas (RL and contractor offices in Richland), and the 1100 Area (equipment maintenance).

Chemical separations process facilities were sited in both the 200 East and 200 West Areas. The 200 North Area temporarily stored irradiated fuel rods, allowing certain short-lived radionuclides to decay before being shipped to separations plants. With the startup of the separation plants, large quantities of liquid wastes (primarily water) containing minor concentrations of radionuclides and chemicals were discharged to the soil column and percolated into the vadose zone. Depending on contaminant concentrations and a consequent need for isolation, liquid wastes were discharged either to surface ponds and ditches or to underground cribs, reverse wells, and french drains. These infiltration facilities were generally located in the 200 Areas near the processing plants and in the surrounding 600 Areas.

Key radionuclides with half-lives longer than 10 years that were discharged to the soil column include cesium-137 (Cs-137), barium-137m (Ba-137m), iodine-129 (I-129), strontium-90 (Sr-90), yttrium-90 (Y-90), technetium-99 (Tc-99), uranium, carbon-14 (C-14), americium-241 (Am-241), plutonium (Pu-239/240), and tritium (H-3 [as tritiated water]). Two-thirds of the radioactivity in liquids discharged to the ground is from tritiated water, which has a 12.3-year half-life. The radioactive material flow diagram for the Hanford Site is shown schematically in Figure 3-1. The least contaminated liquids were discharged to surface ponds and ditches, but comprise over 90%, by volume, of all liquid waste discharges. Conversely, the low volume streams carried 95% of all radionuclides into the vadose zone.

Major chemicals in liquids discharged to ground (based on quantities) include nitrate, sodium, phosphate, sulfate, ammonia, carbon tetrachloride, and fluoride. Inorganic chemicals were used and discharged in much greater quantities than organics. The greatest amount of hazardous chemicals were contained in the liquids discharged from 1945 to 1958 (WHC 1991).

Solid waste such as failed equipment, tools, and protective clothing containing radionuclides and hazardous materials have also been buried in the ground. The radioactive inventory in solid waste burial grounds represents approximately 1% of the total Hanford Site radioactivity (WHC 1991).

The vadose zone underlying these waste sites consists of sediment particles of various sizes and geochemical constituents, soil moisture, vapor, and organic or vegetative matter. The flow of liquid waste through the unsaturated soils in the vadose zone depends in complex ways on several factors, including most significantly the moisture content of the soil and its hydraulic properties. Lateral and vertical gradations or discontinuities in soil-column parameters result in site-specific infiltration characteristics. In addition, waste-stream-specific characteristics of the liquid wastes, such as viscosity and volume, affect the ability of the liquid itself to infiltrate and migrate within the soil column. Contaminants will be transported by migrating water or, in the case of volatile contaminants, by the soil vapor. The resulting distribution of contaminants in the soil column depends on the degree to which different contaminants are retained by adsorption to soil particles or precipitated from the fluid along the migration pathway.

Data Sources. A large volume of historical data is available to present a reasonable idea of the general waste site conditions, local geology, and hydrology for the 200 Areas (Table 3-1), and in a few cases, for specific sites. Since 1947, a large number of boreholes have been drilled, sampled and geologically logged, examined by borehole logging tools, and where deep enough, sampled for groundwater contamination. Soil, vegetation, surface water, and biotic samples have been gathered from the start of plant operations to assess operations impacts on the environment in and around the 200 Areas. Much of this data has been summarized in monthly, quarterly, or annual reports over the last 20 years. In addition, the Pacific Northwest National Laboratory has reported on the Hanford Site's environmental status in its environmental and groundwater annual reports.

A large quantity of this historical data was summarized in the ten 200 Areas AAMS reports. These documents addressed the eight geographically-based source areas and the 200 East and 200 West groundwater regimes. Each source AAMS report included descriptions of the generating facilities, waste site and processes; meteorological, geographic, geologic and hydrologic settings: environmental resources (flora and fauna); and existing environmental conditions as determined through routine soil, sediment, vegetation, air, groundwater, surface water and external exposure conditions. This data collection was conducted to monitor radionuclide transport around the site, to determine if exposure limits were being exceeded, and to detect potential problems. The data was of a sufficient quality for these intended purposes, but most of it lacked the analytical and data certification rigor needed for remediation or characterization decisions. However, this data did provide a strong background for defining sites requiring remedial action and allowed better planning of future characterization activities. In more recent years, some qualified data has been made available as a result of characterization activities at RCRA TSD sites and at the 200-BP-1 Operable Unit.

In addition, each AAMS report identified the major potential contaminants and the potential contaminants of concern, and provided conceptual models of contaminant fate and transport as well as exposure and risk assessments. Health and environmental concerns, ARARs, and preliminary remediation alternatives were also presented. The reports also addressed data quality objectives, data gaps, and proposed data-gathering activities. Waste sites were ranked in each AAMS source report based on the state of contamination at each and a path for remediation was proposed, following the Hanford Past Practice Strategy (DOE-RL 1991).

Site data for the source AAMS reports were gathered in technical baseline documents, which were prepared prior to the AAMS reports and which served as the primary reference for them. These documents included the then-current Waste Inventory Data System (WIDS) database entries for each waste site covered in the respective operable units. Additional data were compiled into each site description along with descriptions of plant operations. Key drawing lists, references, and photographs of each waste site were also provided.

Technical manuals prepared for each major processing plant provide discussions of the chemical processes, equipment, waste streams, health and safety requirements, and general plant layout as conceived at the start of operations. However, process modifications are generally difficult to track over the course of a plant's operating life. Historical overviews for most plants are available over the internet at the DOE-RL Hanford home page (www.hanford.gov) under "Hanford History." These documents include a comprehensive bibliography that can help identify older contractor-generated information, which are available through onsite databases and libraries.

Even though a large quantity of information exists, there are still a number of data gaps. Uncertainties are evident in such areas as the process descriptions, discharge records associated with the operations, the types and quantities of waste generated and sent to individual waste sites, and the interactions of those wastes with the environment at the disposal sites. Current fate and transport models do not adequately quantify the chemical and geochemical interactions influencing the distribution of contaminants in the soil column. It is for these reasons and those discussed above that characterization information is still required.

3.1 PHYSICAL SETTING

A brief summary of the significant characteristics of the physical setting is included in this section to support development of the preliminary conceptual models of contaminated distribution (Section 3.3) and exposure pathways (Chapter 5). A more detailed description of the physical setting is provided in Appendix F.

Disposal of low-level, radioactively contaminated waste water to the ground in the 200 Areas was based on the assumption that the radionuclides would be largely retained in the vadose zone through sorption to sediment particles as the water migrated toward groundwater. (As will be discussed in Section 3.3, subsequent site-specific observations showed that this broad assumption could not be applied in all circumstances.) Because the 200 West, 200 East, and 200 North Areas are located on an elevated, flat area, often referred to as the 200 Areas Plateau, the underlying vadose zone is relatively thick, providing additional opportunities for sorption during migration. The increased thickness of the vadose zone in the 200 Areas also increases the travel time for contaminants to reach groundwater. The vadose zone beneath the 200 West Area ranges in thickness from less than 50 m (165 ft) to more than 100 m (328 ft); the vadose zone beneath the 200 East Area ranges in thickness from 37 m (123 ft) to about 104 m (317 ft); and the vadose zone beneath the 200 North Area ranges in thickness from about 49 m (160 ft) to 50 m (165 ft). The inland location of the 200 Areas, relative to the Columbia River, also increases the travel time for contaminants that do reach groundwater to migrate to the river.

The vadose zones underlying the 200 Areas are relatively permeable, which allows waste fluids to infiltrate, to migrate downward, and to come into contact with sediment particles. Under all three areas, the vadose zone includes the uncemented, unconsolidated gravels and sands deposited by cataclysmic flood waters released from western Montana and northern Idaho when ice dams were breached during the last ice age. In the 200 West Area only, the vadose zone also includes an underlying and less permeable layer of finer grained silt and cemented gravels, which in turn is underlain by consolidated gravels deposited by the ancestral Columbia River system. This less permeable layer acts as a temporary barrier to the vertical movement of liquids and vapors and may cause lateral spreading of contaminated fluids along its upper surface.

Liquid wastes that flow through the vadose zone along preferential pathways may carry contaminants directly to the groundwater with minimal interaction with sediments. Preferential pathways may be artificial, such as poorly sealed wells, or natural, such as clastic dikes and fault zones. Vapor-phase contaminants may also flow along preferential pathways, but in addition to flowing downward may also be released to the atmosphere as a result of barometric pressure fluctuations.

The discharge of large volumes of liquid wastes to the soil columns under the 200 Areas provided the primary driving force for liquid and contaminant migration through the vadose zone toward groundwater. With the nearly complete cessation of these liquid discharges, this driving force has been largely eliminated, and the principal driving force has become natural recharge provided by rainfall and snowfall. Because the mean annual precipitation, approximately 17.3 cm/year (6.8 in./year), is relatively low at the Hanford Site, the natural recharge of water that can drive contaminants through the vadose zone toward groundwater is relatively low.

Plants may redistribute and concentrate contaminants through root uptake followed by either transpiration to the atmosphere or consumption by animals. Contaminants brought to the surface by burrowing animals may be further redistributed by wind or other animals. The maximum depth to which plant roots penetrate and animals burrow is approximately 3 m (10 ft). Most of the more radioactively contaminated liquids were discharged to structures buried to depths of 4 to 10 m (12 to 35 ft), but have not always been beyond the reach of surface-based organisms.

3.2 OPERATIONAL OVERVIEW

The section presents summaries of the generation and disposal of radiological and chemical contaminants in the 200 Areas subsurface (Sections 3.2.1 and 3.2.2) to support development of the waste site grouping rationale (Section 3.2.3), the waste site grouping prioritization (Section 3.2.4), and the lists of major potential contaminants (Section 3.2.5). Characteristics of the waste site groups are described in more detail in Appendix G. The major chemical separation processes and waste management activities in the 200 Areas are described in more detail in Appendix H.

3.2.1 Uranium-Plutonium Production Cycle

Radionuclides brought to the 200 Areas within irradiated fuel rods have three primary sources: naturally occurring uranium isotopes remaining in the fuel rods, products of U-235 fission, and products of neutron activation.

Naturally Occurring Uranium Isotopes. Uranium exists as a naturally occurring element and is commonly found as a trace component of granitic rocks. Economically valuable deposits in the southwestern United States are most commonly found in sandstones. In nature, uranium is comprised of three isotopes: U-238 (99.283% by weight) and trace quantities of U-235 (0.711%) and U-234 (0.006%) (CRC 1980). For reactor use, uranium was concentrated and refined into a pure metal form. The uranium fuel rods initially contained uranium isotopes U-238, U-235, and U-234 in the same naturally-occurring relative abundances.

Throughout the history of Hanford reactor operations, the primary fuel used was metallic uranium. Unique properties of the various uranium isotopes were essential to the production of nuclear weapons. For example, U-238 can be transmuted to U-239 by neutron bombardment; U-239 then decays to Neptunium-239 (Np-239), which in turn decays to Pu-239. Although neutrons may be generated by a number of atomic-scale particle interactions, U-235 fission is the primary source for neutrons in a fuel rod. Two neutrons are released when a U-235 nucleus captures a neutron and fissions, or splits, into smaller nuclei. This two-for-one neutron exchange is the basis for fuel rod enrichment and the power reactor operations. Similarly, the neutrons given off in this reaction may be captured by the nucleus in a U-238 atom, thereby converting it to Np-239. However, in a single, isolated fuel rod, the frequency of neutron capture is miniscule as the neutrons primarily escape from the rod.

A self-sustaining neutron flux, or criticality, can be engineered when a "critical mass" of uranium is assembled. The critical mass assures that the free neutrons will encounter more U-235 nuclei, thus multiplying the number of neutrons generated. When placed in a reactor filled with a large number of closely spaced fuel rods, the neutrons have a much greater opportunity to also encounter U-238 atoms in other fuel rods, and the generated neutron flux begins to transmute U-238 to Pu-239. In practical terms, the amount of plutonium generated at Hanford was dictated by reactor power levels and residence time the fuel rods spent in the reactors, but usually didn't amount to much more than 0.05-0.2% Pu-239, by weight. Because reactor operations consumed U-235 through nuclear fission, its concentration was reduced in the discharged fuel rods by approximately 15% to 25%. Similarly, U-238 was also consumed through transmutation to Pu-239, but at a much smaller scale.

When uranium is found in nature, it is in equilibrium with nearly 30 radioactive daughter isotopes that are created by decay of a radioisotope to a new isotope (either radioactive or stable); the new isotope is the "daughter" of the "parent" isotope from which it descended, as illustrated by isotope-specific decay "chains" (Figure H-9). Chemical separation and purification of uranium prior to fabrication of fuel elements removed all daughter isotopes except U-234, which is a daughter of U-238. The removed daughters begin to be formed again immediately as (1) uranium decay produces radioactive daughters and then as (2) those daughters decay to additional products further along the decay chain. Most uranium daughters "grow-in" very slowly because of the occurrence of several long-half-life daughters early in the decay chain. As a result, daughter isotopes in the lower portions of the decay chain with mass numbers less than 231 (e.g., thorium-230 and radium-226) require greater than 1,000 years (often greater than 10,000 years) before returning to even 1% of the activity of the parent uranium. The daughters lower in the decay chain may be present naturally at low levels but are not considered to be abundant in the 200 Areas.

Products of U-235 Fission. A broad spectrum of fission products form from the splitting of the U-235 nucleus. Although the fission process is randomly able to form any lower element in the periodic table, the U-235 nucleus tends to split into two elements (binary fission) whose atomic mass numbers (= the number of protons and neutrons in the nucleus) usually lie between 72 and 166. Occasionally, the U-235 nucleus will split into three elements (ternary fission) which tends to yield radionuclides with low atomic mass numbers. Most of the resulting isotopes are radioactive, with half-lives ranging from seconds to thousands of years in duration. However, in general terms, 90% or more of the fission products generated from uranium disintegrations possess half-lives less than 1 year long and 50% possess half-lives less than 1 month long. It was for these short-lived radionuclides that cribs and reverse wells were constructed to isolate the waste streams to the site work force and the accessible environment.

After 15 years of decay, more than 99% of the initial fission product activity has been exhausted. The high-activity fission products initially present in irradiated fuel (and of greatest importance during processing) have decayed to insignificance in Hanford materials. Due to their half-lives (approximately 30 years) and significant production during nuclear fission, Cs-137, Sr-90, and their primary daughters, Ba-137 and Y-90 and Zr-90, now account for over 99% of all remaining nonactinide radioactivity (i.e., not from uranium, plutonium, neptunium, americium, etc.) from the fuel materials brought to the 200 Areas.

Two other fission products may be included as potential contaminants because of their half-lives, yields, and potential for concentration or potential for high mobility: tritium (H-3) and technetium-99 (Tc-99). As tritiated water, tritium behaves chemically as any other waste in separation processes. The potential exists for condensate from any contaminated aqueous streams to have H-3 as the primary (or only) radionuclide present. Tc-99 tended to behave chemically the same way uranium did in the chemical processes used at the 200 Areas and potentially contributes significantly to the total radioactivity of uranium-containing streams and wastes.

Products of Neutron Activation. The primary purpose of irradiation of the uranium fuel rods at Hanford was neutron activation of U-238 to ultimately form Pu-239. Neutron activation is the production of a radioactive isotope by absorption of a neutron. During irradiation, however, neutron activation of other isotopes, including newly formed isotopes, also occurred. For example, a fraction of the Pu-239 was converted to Pu-240 and a fraction of the Pu-240 was converted to Pu-241. Because Pu-241 has a short half-life (14.4 years), much of the Pu-241 generated at the Hanford Site has already decayed to americium-241 (Am-241), which must be considered as a potential contaminant of concern whenever plutonium is known or expected to be present. The vast majority of potentially formed activation products have short to very short half-lives. Decay since discharge from the reactors has reduced the number of isotopes potentially present at levels of potential concern to cobalt-60 (Co-60), nickel-63 (Ni-63), carbon-14 (C-14), and H-3 (which may also be present as a fission product). Co-60 has the shortest half-life of these (5.27 years) and is currently approaching its practical detection limits for routine analytical techniques.

Relationship Between Activity and Chemical Concentration. The relationship between the activity of a radionuclide and its mass is called the specific activity, defined as the number of Curies per gram of radionuclide. (A Curie is the activity of that mass of a radionuclide in which 3.7×10^{10} atoms decay per second.) A very low-activity radionuclide such as U-238, with a half-life of 4.51×10^{9} years, requires 3,000,000 g to generate this number of disintegrations per second. Conversely, a high-activity radionuclide such as ruthenium-106 (Ru-106), with a half-life of 1.004 years, requires only 0.0003 g to produce 1 Ci of activity. In other words, the activity measured in a sample corresponds to a smaller mass of radioactive material if the sample contains a high-activity radionuclide and to a larger mass of radioactive material if the sample contains a low-activity radionuclide. In particular, for high-activity radionuclides, the mass required to produce the measured activity may be too small to affect the chemical and physical properties of the sample as a whole. The specific activity for each radionuclide provides the conversion factor between chemical concentration and activity for that isotope.

The end products of radionuclide decay chains are stable elements. For example, uranium isotopes will eventually decay to lead, while strontium and cesium decay to zirconium and barium, respectively. For most of the high-activity/short half-life isotopes, concentrations of the decay chain stable products are very low because the concentrations of the radioactive parents are very low. For low-activity/long half-life isotopes, the formation of stable decay products can be very slow. Therefore, the radiological health hazards overshadow the chemical toxicity of the stable daughter products for any foreseeable time scale. However, for "heavy" elements, both the parent and the daughter elements (e.g., uranium and lead, respectively, which are both heavy metals) will have similar nonradioactive toxicological properties.

3.2.2 Operational History

Plutonium production began at the Hanford Site with the delivery of cylindrical metal uranium billets to the 300 Areas. The metal was heated, forced through an extrusion die, and formed into a cylindrical rod before air quenching and inspection. The rods were machined and cut into slugs 20 cm (8 in.) long. The slugs were then canned inside aluminum jackets and bonded to the material with an aluminum-silicon alloy. The canned slugs were machined, degreased, inspected, and tested prior to being loaded into nuclear reactors in the 100 Areas.

The slugs were placed in the reactor pile and irradiated for variable periods of time, typically for 100 to 120 days, in the early years of operations. Following irradiation, the slugs were pushed out from the reactor pile and collected in basins for initial cooling. The slugs were then loaded into water-cooled casks and taken by railcar to the 200 North Area, where the casks were unloaded into cooling pools. Aging the slugs for 40 to 60 days in the cooling pools allowed the decay of certain high-activity radionuclides such as iodine-131 (I-131) and other short-lived emitters. Additionally, neptunium-239 (Np-239) would also decay rapidly, forming much of the slug's Pu-239 content. The 200 North Area was used between 1945 and 1952, after which aging in reactor cooling basins became standard practice.

The fuel rods were next taken to either the 200 East Area or 200 West Area for processing in one of the separations plants. The various separations processes are described in more detail in Appendix G of this plan. All separations processes required decladding of the fuel slugs by caustic dissolution of the aluminum jacket. Following that, the uranium fuel rod was dissolved in a bath of nitric acid in preparation for the particular separations process steps. The initial bismuth phosphate ($BiPO_4$) process at B and T Plants separated and concentrated plutonium from the rest of the dissolved material by multiple steps of carrier precipitation. The $BiPO_4$ preferentially attracted the plutonium from the rest of the solution and, as a precipitate, was physically separated by centrifuging. Repeated dissolution and precipitation, using both $BiPO_4$ and lanthanum fluoride (LaF), led to recovery of over 99% of the plutonium and removal of 97% to 99% of the uranium and fission products. This process generated large volumes of uranium- and fission product-rich wastes, which were stored in the 241-B, C, T, and U tank farms. Most low-level liquid wastes generated by this process were sent to ponds. The B Plant operations ended in late 1952, and T Plant operations ended in late 1956.

The $BiPO_4$ process was a relatively slow, stepwise approach to recovering plutonium and required large volumes of tank storage space for high activity wastes.. Organic solvent extraction processes were evolving during the 1940s and were applied in the late 1940s with implementation of the Reduction Oxidation (REDOX) process at the 202-S Plant. Immediate benefits in production were observed from the plant's ability to operate continuously. This plant used the organic compound, methyl isobutyl ketone (MIBK or hexone), as a solvent to remove both plutonium and uranium from the dissolved fuel rod solution. The process passed the dissolved, acid fuel rod solution down tall columns by gravity flow, through a less dense, rising countercurrent of organic liquids. Through mixing, both plutonium and uranium were stripped out of the acid by the hexone, which was pulled off at the top of the column. Next, plutonium was removed from the uranium-rich hexone solution and purified, in this case using inorganic acids to preferentially bond with the plutonium in similar countercurrent flow columns. Uranium was recovered using similar extraction processes in a separate set of process columns. Recovery and reuse of the solvent and acid was also achieved through this process. High fission-product wastes generated at REDOX were stored in tank farms. Because it operated continuously, the plant also generated significant quantities of low-level wastes, which were discharged to ponds and cribs. The REDOX process operated from 1951 to 1967, and a waste concentrator was active through 1973.

The Plutonium/Uranium Extraction (PUREX) process at the 202-A Building was the final large-scale separations process developed. It utilized the same countercurrent flow principles of solvent extraction as at REDOX, but benefited from significant design and process improvements. Again, as at REDOX, both plutonium and uranium were recovered and purified, as were the solvents and acids. The plant used a much less flammable two-part organic mix, tributyl phosphate (TBP) in a normal paraffin hydrocarbon (NPH-a.k.a. kerosene), to separate plutonium and uranium from the nitric acid-dissolved fuel rod solution. The TBP process was much more efficient in the rate of processing, and was also safer and cleaner in operation. PUREX began operation in late 1955 and ran continuously to 1972. Following an 11-year hiatus, the plant was restarted in 1983 and ran intermittently through 1988. High fission-product wastes generated at PUREX were stored in tank farms. The plant also generated significant quantities of low-level wastes, which were discharged to ponds, cribs, and french drains.

The recovered, purified plutonium was refined to one of several forms depending upon the era and the available process. At the start of Hanford operations, plutonium was refined in the 231-Z Building where it was converted to a nitrate paste prior to shipment offsite. Shortly thereafter, however, a more elaborate plant, the Plutonium Finishing Plant (PFP), was constructed with the capability to convert plutonium into metal, nitrate, or oxide forms. A number of process lines in the 234-5Z Building were used between 1949 and 1989. Initially, batch inorganic chemical steps were used to refine and convert plutonium to the desired form. Later, more elaborate extraction processes were developed. The PFP was also used to fabricate plutonium into shapes for direct installation into weapons and for reprocessing scrap plutonium, using solvent extraction techniques based on TBP mixed with carbon tetrachloride.

In the first 7 years of $BiPO_4$ operations, over 4,000 tons of uranium were accumulated in the existing tank farms serving the B and T Plants (Gustavson 1950). A dependency on overseas uranium reserves led to the first application of the TBP process, later implemented as the PUREX process, at the 221/224-U Plants in late 1951. The Uranium Recovery Project (URP) and its plant was the focus of an effort to pump out all tanks bearing uranium-rich, high-level wastes in both the 200 East and 200 West Areas. The process was also intended to free up large volumes of tank space. The 221-U Plant recovered the uranium from the various forms of tank farm feed and concentrated it as uranyl nitrate hexahydrate (UNH). The UNH was then sent to the 224-U Building where it was combined with REDOX and later with PUREX uranium solutions. The 224-U Plant used furnaces to convert and calcine the uranium into a dry trioxide powder.

High-level waste storage was an operational concern for production facility operation throughout the 200 Areas. The $BiPO_4$ process generated large quantities of liquid waste, which necessitated construction of four additional tank farms. An initial approach to declining tank space was to pump the least contaminated low-activity supernatant of the stored waste streams to nearby cribs. Next, evaporators were built in 1952 at the 241-B and -T tank farms to reduce the volume of liquids in storage. The URP was expected to significantly decrease the volume of liquids in tanks. However, due to high concentrations of Cs-137 and Sr-90, the process increased the volume of waste requiring tank farm storage. A treatment was found in 1954 to reduce the amount of fission products (especially Sr-90) in the high-level URP wastes by scavenging (precipitation through chemical additions), and the treated liquids were determined to be suitable for discharge to the soil column. In addition, certain tank farm waste streams discharged by REDOX and PUREX were found to be self boiling from the high fission product concentrations and were able to receive more waste over time. At about the same time, more tank space was freed-up in 1954-1955 by discharging another of the less contaminated high-level waste stream supernatants to the ground. This option was acceptable as the waste had been stored for a number of years and much of the fission product contamination had naturally precipitated-out in the tanks. In-tank evaporation was implemented at the 241-BX Tank Farms in the 1960s, and two new evaporators were built at the 241-S (1973) and 241-A (1978) Tank Farms.

Several waste fractionization campaigns were conducted between 1963 and 1983 to recover certain radionuclides, including Cs-137, Sr-90, and certain rare-earth isotopes, for which specific uses or applications had been identified. The program was implemented at the 221-B facility and used a variety of chemical processes, including solvent extraction and ion exchange, to recover target isotopes. The program was superseded by the Waste Encapsulation and Storage Facility (WESF), which concentrated cesium and strontium into dry salt compounds. The powders were then placed in doubly welded capsules and stored in cooling pools.

Many of the full-scale production processes described above were developed in laboratories, both at experimental and bench-scale levels, using small quantities of nonradioactive elements or small quantities of radioactive isotopes. Prior to full plant implementation, tests were performed in near full-scale vessels and at working concentrations to examine problems in scaling-up the chemical principles and processes. This "semi-works" scale of testing was conducted at one of two places. The earliest $BiPO_4$ developmental testing was conducted in the "Headend" section of the 221-T Building. However, much more extensive development work for REDOX, URP, PUREX, and the fission product fractionization processes were undertaken at the 201-C Building, also known as the Hot Semi-Works facility. This area was originally intended to be a fourth $BiPO_4$ plant, but construction was canceled after U Plant was started. The remaining facilities then under construction were modified and completed to allow safely working with significant quantities and concentrations of radionuclides and chemicals.

Additional details of these and other, secondary operations are presented in Appendix H.

3.2.3 Waste Site Grouping Rationale

The waste site grouping strategy used in this Implementation Plan is summarized from a broader discussion presented in the *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997). The strategy is an implementation of the analogous site approach advanced in the *Hanford Past Practice Strategy* (DOE-RL 1991) in which the results of characterization activities at one or several sites in a waste group are extended to all sites in that group. At the core of the grouping approach is the recognition that there are a limited number of liquid waste types generated by any given facility or process. The concentrations of both radiological and chemical contaminants in each stream type were fairly distinct, as typified by the types of waste sites to which the liquids were discharged. In general, liquid wastes with small quantities of radionuclides were discharged to subsurface structures such as cribs and reverse wells. Waste streams with negligible quantities of radionuclides were discharged to surface structures such as ponds and ditches.

The use of analogous site data reduces the amount of investigation needed at individual waste sites by performing characterization activities for groups of similar waste sites. This analogous site approach concept is a key element in the 200 Areas soil remediation process because many of the 200 Areas waste sites share similarities in process history, contaminants of concern and geological conditions. The *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997) identified logical waste site groups based on waste stream type (e.g., solid waste, cooling water, process waste), followed by waste site type (e.g., burial ground, pond, crib). It was determined that the waste stream categories and specific groups within the categories would provide the most efficient method of grouping waste sites, based on current knowledge about the facilities generating the waste and the waste site types themselves. In addition, it was recognized that while the 200 Areas contain a large number of waste sites, only a limited number of chemical separations or waste treatment processes and waste disposal structure types were actually used. More detailed information on waste streams and waste sites is presented in Appendix G. Plant processes are discussed in detail in Appendix H.

A subteam with representatives from the Environmental Restoration Contract (ERC), Ecology, the EPA, and the RL developed waste site categories and criteria. Chemical processes, type of contamination (e.g., uranium, plutonium, organics), and waste site type (e.g., pond, crib, burial ground) were identified as the primary factors used to categorize sites. The following waste categories were developed:

- Process condensate and process waste sites
- Steam condensate, cooling water, and chemical sewer sites
- Chemical laboratory waste sites
- Miscellaneous waste sites
- Tank and scavenged wastes sites
- Septic tanks and drain fields
- Unplanned releases
- Tanks, lines, pits, and boxes
- Landfills and dumps.

Individual waste site data were reviewed for:

- Location
- Waste source and associated chemical process
- Volume of liquids received
- Type of contaminant(s) received and associated cumulative inventory
- Waste site type/structure.

Sites that were not addressed included those inside and ancillary to the single- and double-shell tank farms and the respective process or waste management buildings. These sites will be addressed as part of the TSD closure activities at the respective tank farm operable units or as part of the D&D activities at major process buildings.

The ***Process Condensate and Process Waste*** category includes waste sites that are typically below ground liquid waste disposal structures (e.g., cribs and trenches). Process condensate is generally water condensed from the closed process system and was in direct contact with radioactive and chemical materials. Process waste is low-level and/or hazardous waste that directly contacted radioactive material and may contain organic complexants that could enhance their mobility. Due to the small quantities of radionuclides, this waste was disposed to underground sites such as cribs, reverse wells, and trenches. The primary contaminants noted in this category include H-3, I-129, Cs-137, Sr-90, Ru-106, Tc-99, U-238, Pu-239/240, organics, nitrates, and a number of inorganic components.

This category was subdivided into six groups, based primarily on the respective amounts of key constituents (uranium, plutonium, organics, fission products [e.g., Sr-90 and Cs-137]) and other process-related information. Available inventory data for each process condensate/process waste site was evaluated to determine how that site compared with others where high inventories for uranium, plutonium, fission products, or organics were present. Lower bound values for each constituent were established, and sites with less-than inventories were considered either for inclusion in other constituent groups or, if still less-than, were placed in the General Process Condensate/Process Waste Group. An arbitrary hierarchy of constituents emerged with uranium-rich, plutonium-rich, and plutonium/organics-rich groups regarded as the more important due to the longer half-lives associated with each. Organic and fission product-rich groups were considered next in importance, and the General Process Condensate/ Process Waste Group served as the catch-all for sites with small inventories. Inventory data are presented in Appendix A, Table 1, of the Waste Site Grouping for 200 Areas Soil Investigations Report (DOE-RL 1997). These groups are:

- **Plutonium/Organic-Rich Process Condensate/Process Waste Group (200-PW-1).** This is one of two process condensate/process waste groups with both contaminant-based and facility-based relationships. These sites are associated with the 234-5Z PFP and 236-Z PRF buildings and are known or suspected to have received quantities of both carbon tetrachloride and plutonium. Carbon tetrachloride is considered to have indirectly assisted plutonium movement, although it did not bind with the plutonium.

- **Uranium-Rich Process Condensate/Process Waste Group (200-PW-2).** This group addresses those sites that received large quantities of total uranium (U-238), primarily from waste streams generated during the dissolution of fuel rods. The uranium inventory may range up to 38,500 kg, but a minimum inventory of 150 kg qualified a site for inclusion in this group.

- **Organic-Rich Process Condensate/Process Waste Group (200-PW-3).** This group encompasses all sites that are known to have received methyl isobutyl ketone (MIBK, a.k.a. hexone), normal paraffin hydrocarbons (NPH), and tributyl phosphate from the PUREX, REDOX, URP, or Semiworks plants. These compounds were used in solvent extraction processes and are suspected of increasing radionuclide mobility in the soil column. Most organics are expected to have vaporized or biodegraded after entering the environment, but others may persist. A minimum organic inventory of 2,900 kg qualified a site for inclusion in this group.

- **General Process Condensate/Process Waste Group (200-PW-4).** This group includes the remaining sites that received process condensates and wastes with lesser quantities of chemical and radiological constituents than the minimum values used for inclusion of sites in other groups in this category.

- **Fission Product-Rich Process Condensate/Process Waste Group (200-PW-5).** Large curie inventories of Sr-90 and Cs-137 were recognized for process condensate/process waste sites across the 200 Areas. A minimum inventory of 20 Ci for either cesium or strontium qualified a site for inclusion in this group, based on potential for direct exposure.

- **Plutonium Process Condensate/Process Waste Group (200-PW-6).** This group is defined by its proximity to the 231-W plant and addresses waste sites where plutonium was the primary contaminant. Up to 340 g of Pu-239/240 and 1,373 g of Am-241 were discharged to the soil column at these sites. A minimum plutonium inventory was not used to qualify sites for inclusion in this group.

The ***Steam Condensate, Cooling Water and Chemical Sewer Waste*** category includes site types that were typically, but not exclusively, constructed at ground level (e.g., ponds, ditches, retention basins). In all cases, the waste streams were run in a noncontact manner; that is, a barrier separated the liquids in this category from contaminated process liquids, with little consequent potential for routine radiological contamination. However, contamination did enter these streams in generally negligible to very small quantities through pinhole leaks or through rare pipe ruptures. By virtue of the quantities of liquids used, significant inventories of contaminants were built up at the waste sites.

All separations facilities generated these three waste stream types, but only the REDOX, PUREX, and B Plant waste fractionization processes had waste sites specifically dedicated for each stream. The $BiPO_4$ processes at B, T, and U Plants discharged the three waste streams to their pond systems. Cooling water accounted for over 90% of all liquids discharged to the soil column. Chemical sewers, typically discharged to unlined ditches, were intended to receive nonradioactive, dilute chemical waste from the major solvent extraction processing facilities. Steam was used to heat process solutions at certain steps in all major process facilities, and the condensed liquid was usually discharged to cribs. There are a total of seven groups in this category, of which five are cooling water groups based on geographic locations related to major process facilities. The waste groups in this category are:

- **Gable Mountain Pond/B-Pond and Ditches Cooling Water Group (200-CW-1).** Waste sites in this group received primarily cooling water from all major facilities in the 200 East Area. Many sites are outside the fence line. The waste sites also received chemical sewer and steam condensate wastes from 221/224-B operations during $BiPO_4$ processing.

- **S-Pond/Ditches Cooling Water Group (200-CW-2).** Several ponds and ditches were used to percolate REDOX cooling water. The ponds and ditches are located south and southwest of the 200 West Area fence line.

- **200 North Cooling Water Group (200-CW-3).** Waste sites in this group include a series of cooling water ponds and cleanout trenches for the 212-Fuel Storage Basin facilities used to age "green" irradiated fuel rods. These waste sites are an isolated set of units located in the 200 North Area.

- **T-Pond/Ditches Cooling Water Group (200-CW-4).** Several ponds and ditches are associated with the multiple activities conducted at the T Plant facilities. These sites also received chemical sewer and steam condensate wastes during the $BiPO_4$ operations at 221/224-T. The waste sites are located inside the northern part of the 200 West Area fence line.

- **U-Pond/Z-Ditches Cooling Water Group (200-CW-5).** Waste sites in this group are commonly inside the 200 West Area fence line and received cooling water steam condensate and chemical sewer waste from the major process facilities in the central part of 200 West Area.

- **Chemical Sewer Group (200-CS-1).** The waste group consists primarily of ditch waste sites that received unknown quantities of inorganic and/or organic chemicals. Radionuclide inventories are very small to negligible, although several sites have a uranium component.

- **Steam Condensate Group (200-SC-1).** This group encompasses those crib waste sites to which radiologically contaminated condensate steam was discharged. These cribs tend to have significant radiological inventories due to failures or leaks in heating coils.

The ***Chemical Laboratory Waste*** category includes sites that received laboratory process wastes or laboratory decontamination wastes. Two groups were developed for this category, based largely on the potential differences in the nature of chemicals used at the 200 and 300 Area laboratories.

- **300 Area Chemical Laboratory Waste Group (200-LW-01).** Developmental laboratories in the 300 Area (324, 325, 327, 328, and 331 Laboratories) generated significant quantities of liquid wastes that were collected at the 340 Complex and transported to selected 200 Area cribs and trenches by truck or rail. In addition, cooling water contaminated by a 1965 fuel rod rupture at the 309 Reactor facility was trucked to the 216-BC Cribs area. More recently, the 340 Complex wastes have been shipped to the 204-AR Vault for disposal to the 241-A Tank Farms. The waste inventory is generally very low for all radionuclides, but instances of significant values of uranium, plutonium, and fission products are known. Several waste sites in the 200 Laboratory Waste Group (216-Z-7 and 216-S-20 Cribs) are suspected to have received this waste stream, but radiological/chemical/ volume characteristics do not allow a differentiation between the groups.

- **200 Areas Chemical Laboratory Wastes Group (200-LW-02).** In the 200 Areas, the 222 Laboratory facilities at the S, T, U, and B Plants provided analytical services for process control to the major processing plants and generated liquid wastes that were discharged to french drains, cribs, reverse wells and, for solid wastes, to underground vaults. Chemical laboratory waste sites are also known at PUREX and PFP, but are grouped elsewhere because they were combined with other waste streams at the soil column disposal sites. These waste streams are generally very low in radionuclide concentrations, although significant inventories of plutonium, uranium, and fission products are known. Sodium dichromate is reported at several waste sites. Liquid volumes are typically low.

The ***Miscellaneous Waste*** category (200-MW-1) contains most of the french drains onsite plus a few cribs and reverse wells. Most streams in this category are very low in radionuclide and chemical constituents, except for several waste streams associated with the PUREX facility, and were not routinely monitored. These sites received liquid wastes associated with plant ventilation and stack drainage, equipment decontamination, and a number of small-to-medium volume radioactive waste streams from multiple sources. Four french drains inside the 241-A Tank Farms (216-A-16, 216-A-17, 216-A-23A, and 216-A-23B) received liquids from the 241-A-431 Fan House building, but are placed in the PUREX Tank Farms Operable Unit (200-PO-3). Likewise, the 216-A-39 Crib, associated with a release at the 241-AX Tank Farms, is also grouped in 200-PO-3. Several unused sites that were built but never used (216-A-38, 216-B-56, and 216-B-61 Cribs) have been placed in this category for completeness. This category was not further subdivided into groups.

The ***Tanks/Scavenged Waste*** category consists of two groups of streams that have received the most highly contaminated wastes sent to the ground. These wastes are associated, directly or indirectly, with tank wastes collected from the $BiPO_4$ process. Both streams are characterized by significant concentrations of both radionuclides and inorganic chemicals.

- **Scavenged Waste Group (200-TW-1).** The Scavenged Wastes group was derived from certain uranium-rich $BiPO_4$ wastes generated by the URP at the 221-U Plant. The wastes were treated with a scavenging agent, ferrocyanide, that precipitated out most of the fission products remaining after uranium extraction. Treatment was initiated at the tail end of the URP and also in the 241-CR vault at the 241-C Tank Farms. Scavenged wastes were sent to the ground in limited quantities at a number of 200 East Area cribs and trenches under a specific retention discharge philosophy that restricted the volume of liquids released at any one site.

- **Tank Waste Group (200-TW-2).** The Tank Wastes Group consisted of lower activity liquids overflowed to the ground at cribs and trenches from two of the less contaminated, $BiPO_4$ high-activity tank farm waste streams. In addition, a medium-level waste stream derived from process vessel rinses and drainage was sent to the ground at cribs and reverse wells. Fission products in the waste were precipitated out during cooling and storage in the tanks, and the residual liquid was released to the ground in small to moderate quantities.

The ***Tanks/Lines/Pits/Boxes Waste*** category (200-IS-1) consists of structures used to convey or control the conveyance of waste from source generating facilities to tank farms or other processing facilities. The category consists of those facilities used to handle the high-level plant wastes generated from separations or volume reduction processes. No wastes were intentionally released to the ground from this category, but a number of unplanned releases are known. The category was established as a means to identify high-level waste lines outside tank farms and processing facilities, but with the recognition that remediation of these facilities will ultimately be associated with tank farms stabilization. Note that diversion boxes, valve pits, sampler pits, pipelines, and other waste site types constructed in support of a soil column disposal waste site will be considered within the group that waste site has been placed in.

The ***Unplanned Release*** category (200-UR-1) are waste sites resulting from the loss of control over a liquid, gaseous, or solid, radiological or hazardous material in the course of processing, handling, or shipping the material onsite. All unplanned releases not specifically associated with a waste site were categorized under the Unplanned Release category. Unplanned releases that are associated with particular waste sites are placed in that group and will be characterized with the respective waste site. No groups within this category were identified.

The ***Septic Tanks and Drain Fields Waste*** category (200-ST-1) contains sites that have received or continue to receive largely nonradioactive, nonhazardous, sanitary sewer waste. Wastes include human waste as well as shower water, janitorial and lunchroom water, and drinking water. The potential for radiological contamination does exist through the shower and janitorial sink sources, and where present, is very small. Chemical constituents such as soaps and detergents are expected in very small quantities. The quantities of liquids discharged were not tracked.

The ***Landfills and Dumps Waste*** category contains solid waste burial and debris sites and was subdivided into the following groups based on radiological inventory:

- **Nonradiological Landfills and Dumps Group (200-SW-1).** This group covers a number of waste sites including large volume contaminants placed in specific engineered locations, such as powerplant flyash at the 284-E and 284-W ashpits, and the Nonradioactive Dangerous Waste Landfill (NRDWL) and Solid Waste Landfill (SWL) for unused laboratory and plant chemicals. Small to medium construction debris and dump sites are known, and recent discovery sites are tracked in the WIDS.

- **Radiological Landfills and Dumps Group (200-SW-2).** Sites included in this group consist of constructed or excavated sites (218 Burial Grounds) that received either low-level or transuranic (TRU) wastes. Ten major burial grounds with a number of trenches in each were or continue to be used in both the 200 East and 200 West Areas. Prior to 1970, TRU and low-level wastes were disposed to the same burial ground trenches, but wastes were thereafter segregated according to the low-level or TRU designation. TRU was placed in underground concrete caissons at burial grounds after 1970. Wastes were largely solid materials and mostly from onsite; but off-site and liquid wastes (tightly packed and sealed in drums) are known. These waste sites have the highest inventory of radionuclides of soil column disposal sites.

Plate I provides a pictorial overview of the waste sites included in the 200 Areas Implementation Plan and reflects the locations of waste sites contained within each waste site group. Only the Unplanned Releases Group (200-UR-1) has not been included due to the diversity of locations where these waste sites are found. This plate also identifies areas that are outside of the 200 East and 200 West Areas, such as 200 North and other outlying 600 Area locations that are included in the scope of this document. In addition to color coding the sites within a group and providing the WIDS designation for each waste site, the boundary locations of the former geographically based operable units are also provided. Sites that have been selected as representative sites, and RCRA TSD units, are also shown. Plates II and III provide a closer view of the locations of the waste sites within the 200 East and 200 West Areas, respectively.

The waste sites assigned to groups were based on information available at the time the *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997) was prepared. It is possible that new information may be discovered that would indicate the site belongs in a different group, or that the waste site designation is duplicated elsewhere in WIDS. A number of changes would be necessary, including group redesignation in the WIDS, which is considered to be part of the Tri-Party Agreement. Such changes would require approval of Tri-Party Agreement signatories and alteration to Appendix C of the Tri-Party Agreement. A procedure for revising the WIDS is presented in the Tri-Party Agreement Handbook, RL-TPA-90-0001, Management Procedures "Maintenance of the Waste Identification Data System," Guideline Number TPA-MP-14 (DOE-RL 1990).

The evaluation in the Waste Site Grouping for 200 Areas Soil Investigation report (DOE-RL 1997) was based on a systematic review of available historical data including AAMS reports, the WIDS, and other documents. Each waste site's waste stream description, as well as chemical and radiological inventory data, was used to determine its placement within one of the 23 groups. Representative typical and worst-case waste sites were selected, based on inventory, operational history, notable unplanned releases, and volumes of liquid received to provide a balanced, yet bounded, set of characterization data.

3.2.4 Waste Group Prioritization Process

The Waste Site Grouping for 200 Areas Soil Investigation report (DOE-RL 1997) provided an initial prioritization of the 23 waste groups, according to a broad set of technical criteria that address a number of factors related to groundwater impacts and level of characterization and chemical knowledge, geographic location, implementability of characterization and remediation, and the ability to show progress. The factors weighted the highest included the potential for future degradation of groundwater, the presence of mobile contaminants, poor understanding of chemistry affecting contaminant fate and transport, the presence of several good representative sites for a large group, and sites/groups where characterization/remediation would be relatively easy. The prioritization weighed the current level of knowledge of a waste group's contamination inventory and migration potential and the ability to easily improve on that knowledge versus the risk associated with that group.

Table 3-2 provides the complete list of the prioritization criteria. Each question was posed for each group and was applied for all waste sites in that group. A YES answer was scored according to the relative importance of the question (Low = 1, Medium = 3, Medium-High = 4, High = 5, NO = 0, maximum score = 42). The sum of the individual scores for each group became the basis for the "technical" prioritization of all groups.

The ability to demonstrate significant progress in the 200 Areas characterization and remediation program was considered to be important. Factors considered important to prioritizing groups for this purpose included geographic (outside 200 Area fence lines, broad contamination areas) and waste site types (shallow contamination, more easily and cost-effectively characterized and remediated) considerations. This led to the selection of the next most highly prioritized groups, typically the cooling water pond and ditch systems. Several groups were not ranked or ranked very low, because of the potential for long-term uses of the specific waste sites (e.g., operational considerations). The Radioactive Landfills and Dumps, Septic Tanks and Drain Fields and Tanks/Lines/Pits/Boxes categories/groups were regarded as being required "long-term" for future facility cleanup efforts, represented little threat for environmental/exposure hazards, and were not easily closed until other work on site was completed.

A second administrative screen was then applied to the technical prioritization of waste groups. The administrative prioritization was conducted with the intent of melding existing TPA requirements for performing both RCRA TSD and CERCLA operable unit characterizations. The Tri-Party Agreement (Ecology et. al, 1994) has specified the following items as important to prioritizing remediation efforts:

- Volume of wastes or hazardous substances,
- Hazardous substances identification and classification,
- Toxicity or health effects of the hazardous substances,
- Potential for migration to receptors via all environmental pathways,
- Available technology to investigate/remediate operable unit,
- Operation considerations (timing of decommissioning activities),
- Considerations to those operable units that include TSD Units.

The first six TPA criteria are consistent with the criteria applied in DOE-RL 1997. The last bullet "Considerations to those operable units that include TSD Units", and the objective of coordinating RCRA closure plans and CERCLA work plans, was the primary criteria used to adjust the technical ranking. The TPA major milestones M-20-00 requires that all RCRA TSD Closure/Postclosure plans will be submitted for approval by 2004.

The first consideration was whether there was any immediate need for an Expedited Response Action at sites/groups where chemical or radiological contamination posed an imminent threat to human health and the environment. The carbon tetrachloride plume at 200-ZP-1 and the uranium/technetium-99 groundwater plume at 200-UP-1 were considered to have the greatest impact but were considered to be adequately addressed by the respective pump-and-treat programs and by the 200-ZP-2 soil vapor extraction program. Assuring that there was no longer an imminent health threat, the remaining criteria from the TPA "consideration of those Operable Units that contain TSDs" was then applied to the technical prioritization list. As a result, those waste site groups with RCRA TSD units scheduled for closure were given a higher ranking. Although it has no TSDs, the 200 North Cooling Water Group was placed first as it is analogous to 100 Area sites which are currently in the process of being remediated. Table 3-3 provides a comparison between old and new waste group prioritization.

Additional considerations were also factored into this prioritization list revision. The groups chosen will provide the opportunity to begin characterizing and remediating large areas outside the 200 Area fence lines. A wide variety of both fate and transport contaminant models, as well as conceptual exposure models can be tested with the wide variety of sites and waste streams in these first six groups. The groups chosen will allow testing and refinement of the RCRA/CERCLA integration techniques discussed in Section 2.0 of this document. Other groups will be prioritized in expected accordance with the technical prioritization list in DOE-RL 1997 at a later date.

Only the first six of the 23 waste groups have been specifically defined in the TPA, along with a schedule for the remaining 17 waste groups (see Figure 7-1). As progress is made and additional knowledge is gained in the 200 Areas, more priorities will be established and the remaining 17 waste group priorities will be defined. On an annual basis the DOE, EPA, and Ecology will review the waste group prioritization process to consider the additional knowledge gained, and groundwater and vadose zone integration needs across the site. Any changes in group priority requires approval of the lead regulatory agency.

3.2.5 Major Potential Contaminants

The preceding discussions in Section 3.2 and Appendices G and H present the sources of radionuclides and major processing chemicals used in the 200 Areas. The following summarizes those constituents introduced to the 200 Areas in sufficient quantities to potentially require remediation activities. In addition, this section helps identify additional contaminants that, while not introduced in large quantities, may impact remediation activities due to their extreme toxicity or other potential hazards. Not all identified contaminants will need to be measured at all sites. Specific DQO activities are expected to identify those contaminants on the "master" list that are appropriate for each waste group. The "master" list may be added to, as needed, to reflect new information or site-specific data needs.

3.2.5.1 Radionuclides. Potential radionuclide contaminants are listed in Table 3-4. Note that while samarium-151 (Sm-151) has received little attention in the past, it becomes a significant fraction of total fission product activity after approximately 25 years of decay and will remain significant for up to 1,000 years (100-year half-life). The necessity for analysis of Sm-151 is being evaluated at this time.

All other radionuclides potentially present in the 200 Areas but not included in Table 3-4 are (1) directly tied to the isotopes identified above as descendent daughters (e.g., Sr-90 daughter yttrium-90 [Y-90]) and may be calculated from the parent activity; (2) fission/neutron activation products with less than 0.01% of the Cs-137 or Sr-90 activity (e.g., I-129, selenium-79 [Se-79]) that cannot be readily separated from the major fission product activity contributors for analysis; or (3) alpha-emitting isotopes of the same element in concentrations less than 1% of the primary isotope (e.g., Pu-242 in Pu-239) that cannot be resolved during analysis. It is assumed that minute amounts of additional activity potentially present from radionuclides that are not analyzed for will have no significant effects on remediation decisions.

3.2.5.2 Inorganic Chemicals. Most of the chemicals used in the 200 Area processing were inorganic. The potential inorganic chemicals of concern are listed in Table 3-5. Analyses for inorganic chemicals do not routinely determine chemical compounds (e.g., sodium nitrate), but rather the ionic building blocks that comprise the compounds (e.g., sodium and nitrate separately). Analyses for metals routinely detect a suite of metals that include many relatively innocuous metals (e.g., sodium, iron, aluminum) introduced in large quantities in the 200 Areas. They have not been included in Table 3-5 because even massive concentration levels are not expected to impact remediation decisions.

3.2.5.3 Organic Chemicals. Unlike inorganic chemical analyses, most organic chemical analyses determine specific chemical compounds (or compound groups [e.g., PCBs]). Table 3-6 lists the potential organic contaminants of concern in the 200 Areas.

3.2.5.4 Other Chemicals. Chemicals loosely identified as "complexants" were used in the 200 Areas. These materials range from components of laundry detergents to boiler water treatment compounds to specific complexants such as ethylenediaminetetraacetic acid (EDTA), N-hydroxyethylenediaminetriacetic acid (HEDTA), and citric acid. The largest process use of specific complexants was in the waste fractionation processes (1963-1983) at B Plant. However, these materials were also used in other facilities for cleanout operations and, potentially, cleaning up after plant process upsets. In general, complexants were used to help solubilize materials or assist in keeping components in solution. Most of these compounds are, in themselves, low in toxicity (most of the complexants used at B Plant are available in "food grade" specification). The concern at the 200 Areas is that these materials may increase the solubility of toxic, radioactive, or hazardous materials normally strongly retained on Hanford soils. Unfortunately, there are no simple or readily available analytical techniques for detecting complexant compounds in environmental-type samples. Strategies for dealing with complexants will be developed during group-specific DQOs and sampling and analysis plans.

3.3 CONTAMINANT/SOIL INTERACTIONS

This section presents an overview of the physical and chemical interactions that may occur when wastes from various sources come into contact with the soil column in the vadose zone underlying the source disposal facilities. The characteristics of the waste streams and the sediments, the properties and behavior of the radiological, inorganic, and organic contaminants, and the principles that affect contaminant distribution within the vadose zone provide guidance for (1) designing characterization and remediation activities and (2) assessing the potential for groundwater contamination. The objective of this discussion is to provide the generalized physical conceptual model of contaminant distribution within the 200 West and 200 East Areas. The contaminant fate and transport phenomena are used to support identification and exposure pathways for the major categories of 200 Areas waste streams in Chapter 5.0.

This discussion provides generalized information common to all waste site groups. Preliminary physical conceptual models of contaminant distribution are presented for each waste group in the *Waste Site Grouping for 200 Area Soil Investigations* (DOE-RL 1997). Collectively, this information will provide the foundation for developing consistent site-specific conceptual models of contaminant distribution in individual group-specific work plans.

3.3.1 Physical and Chemical Interactions in the Vadose Zone

The vertical and horizontal distribution of a contaminant in the soil column beneath waste sites is generally dependent on the waste stream's physical properties, which determine how easily and far the waste stream (e.g., water) can migrate, and on the contaminant's chemical properties, which determine its ability to adhere to or react with soil particles along the migration pathway. The major processes affecting transport or retention of chemicals discharged to the vadose zone include precipitation/dissolution, adsorption/desorption, filtration of colloids and suspended particles, and diffusion into micropores within mineral grains (Serne and Wood 1990). Of these processes, precipitation/dissolution and adsorption/desorption are considered the most important.

Other characteristics that can affect the contaminant/soil interaction include the operational characteristics of the disposal unit and the site-specific geological and geochemical properties of the soil column. Because the 200 Area waste streams were generally low salt and neutral to basic pH and because Hanford sediments are generally basic in nature, the behavior of specific contaminants in the soils is generally the same from site to site and primarily dependent on the contaminant's own chemical properties. However, some waste streams contained other constituents such as organics or acids that can alter the contaminant's soil affinity, resulting in either greater or lesser mobility relative to the "typical" situation. The impact of 200 Area site conditions on the mobility of waste water and associated contaminants is summarized conceptually in Table 3-7.

The generalized physical conceptual model of contaminant distribution focuses primarily on the deposition and distribution of contaminants that occurred during the active water discharge phase of the waste site operations. However, wastes discharged to the soil column included solid wastes and volatile liquids that produce vapor-phase contaminants. Both solid and vapor-phase contaminants may be dissolved and carried downward by migrating water. Vapor-phase contaminants may also be transported downward, upward to atmosphere, and/or laterally by migrating soil vapor and may spread by diffusion within soil vapor.

Active discharges provided the primary driving forces for contaminant transport through the vadose zone and in some cases to groundwater. Since cessation of waste discharges, only natural recharge and, in some cases, influences from currently minor artificial sources of recharge are available for continued contaminant transport. However, these driving forces are considered to be much less significant now and in the future relative to the past active discharges.

3.3.1.1. Factors Affecting Contaminant Mobility. A general measure of a contaminant's distribution between soil and water is the soil-water distribution coefficient K_d. This coefficient is experimentally derived and is usually expressed in units of milliliters per gram. A relatively high K_d value indicates that the contaminant will tend to be retained on the soil particles and thus indicates a relatively low mobility whereas a relatively low K_d value indicates that the contaminant will tend to remain dissolved in the water and thus indicates a relatively high mobility (Appendix F). The relative mobility of specific radiological, inorganic, and organic contaminants commonly discharged to 200 Area waste sites is summarized in Table 3-8.

The K_d for a contaminant can be significantly affected by the following:

- The pH of the wastewater and the ionic strength
- The mineral and organic composition of the soil
- The ionic composition of the soil pore water
- Other site-specific factors such as the formation of chemical complexes.

Examples of variation in K_d values for selected radionuclides based on the salt content of the waste solution are presented in Table 3-9.

Effects of pH and Ionic Strength. The pH of the wastewater can increase the mobility of radionuclides such as plutonium and cesium. However, the alkaline nature of the Hanford sediments (due to carbonate content) tends to buffer acidic waste discharges such that the acidity is neutralized quickly near the point of discharge. For example, Johnson (1993) showed that for the 216-Z-20 Crib in the 200 West Area, a 1-m thickness of soil beneath the crib was capable of neutralizing 4×10^9 L of pH 5 water. Contaminants in acidic wastewater are driven deeper into the soil column as the buffering capacity of the soil is exceeded by higher discharge volumes.

Although many contaminants may become more mobile in an acidic environment, increased alkalinity can also increase mobility of some contaminants. For example, although plutonium is typically one of the least mobile of the Hanford contaminants, plutonium mobility is known to increase moderately at pH values above 8.

For some inorganic contaminants, ion exchange is the dominant mechanism leading to desorption. High ionic strength (high salt content) tends to drive the equilibrium toward desorption rather than sorption.

Effects of Composition of Soil. Because Hanford soils are generally neutral to alkaline, there is a net negative charge on the soil particles that facilitates sorption of positively charged cations. Conversely, anionic species that have negative charges are either only weakly sorbed or not sorbed at all.

Mineralogy affects the abundance of sorption sites as well as the availability of ions for precipitation. For example, clays are more sorptive than sands. Also, the clay minerals (e.g., montmorillonite) present in Hanford sediments are the varieties with the greatest exchange capacities.

Sorption increases as soil (sorbent) particle size decreases. Filtration and ion exchange also increase with decreased soil grain size. Filtration effects are more pronounced for contaminants that form insoluble precipitates.

For organic contaminants, partitioning to the soil from the water is affected by the organic carbon content of the soil. The soil/organic matter partition coefficient K_{oc} is an empirical measure of distribution between organic carbon content of the soil and the water phase. K_d is related to K_{oc} according to the relationship $K_d = K_{oc}f_{oc}$, where f_{oc} is the fraction of organic carbon present in the soil. Hanford soils are low in organic carbon content, less than 0.1 wt%, and therefore, estimated K_d s for the principal organics of concern are generally less than 1, indicating high mobility.

In general, the organic compounds that are more soluble in water (acetone, hexone, alcohols, acetone, organic acids, methyl ethyl ketone, chloroform, aldehydes, and ketones) are less likely to adhere to soils, whereas the compounds that are less soluble in water (carbon tetrachloride, trichloroethylene [TCE}, TBP) will adsorb more strongly to soils. Clays and organic matter will favor adsorption of organic solutions.

Effects of Organics and Chemical Complexes. Discharges of organic compounds may also affect mobility by complexing the contaminants. Organic mixtures containing compounds such as hexone, tributyl phosphate (TBP), and carbon tetrachloride were used in the chemical processing plants to separate product components (e.g., plutonium, uranium, americium) from irradiated fuel and its processed derivatives. These organic solvents were effective extractants because of their ability to form stable complexes with the extracted components. Disposal of wastes containing residual concentrations of these organic complexes may have increased the mobility of the contaminants relative to streams not containing the organics.

Sites receiving liquid wastes with surfactants (soaps and detergents) may have contamination at greater depths.

Other Effects. Effects of other factors on contaminant mobility include:

- Valence state. Generally, multivalent ions are more strongly sorbed than univalent ions with similar ionic radii.
- Chemical process. Uranium mobility is affected by the specific form of the uranium compound present as a result of the chemical process that created the waste. Uranium associated with phosphates can form insoluble precipitates that are not mobile. However, in nitrate form or in combination with carbonates, uranium tends to be highly mobile. For example, the transport of uranium to groundwater in the 216-U-1/U-2 Crib system is believed to have resulted from mobilization of uranium present in the crib as a phosphate precipitate by acidic wastes that were discharged to an adjacent crib.
- Contaminant particle size. Deposition of the contamination increases with increasing particle size through precipitation and filtration in the soil media.
- Volume of discharge. Hydrostatic forces are the primary driving force for contaminant migration, so that discharges that maintain saturated conditions in the vadose zone result in more rapid downward migration.

- Lithology. Variations of the soil stratigraphy with depth, such as the presence of low-permeability layers (e.g., the Plio-Pleistocene "caliche" unit in 200 West Area), may increase the length of the flowpath for contaminant migration and thereby slow the rate of descent.

- Wells. Poorly sealed wells may provide a conduit by which contaminants may flow through the vadose zone to the groundwater, bypassing the soil column.

- Clastic Dikes. Clastic dikes, which occur most frequently in the Hanford formation, may provide preferential pathways or barriers for liquid and vapor flow.

- Vegetation. Vegetation or other organic matter (e.g., algae) present in sites such as ponds and ditches may provide some uptake of radionuclides. Alternately, root action in pond or ditch sediments is regarded as maintaining or improving percolation rates.

Natural Attenuation. Natural attenuation relies on natural processes to lower contaminant concentrations through physical, chemical, and/or biological processes, including biodegradation, sorption, oxidation-reduction reactions, and radioactive decay (Appendix D). Contaminants in the discharged waste streams may be reduced or immobilized as a result of interactions with the soils in the vadose zone, thus contributing to natural attenuation of the contaminants.

Biodegradation affects the persistence of organics in the subsurface. Biodegradation of water-soluble organics is more rapid under the oxidizing conditions found in Hanford soils, whereas the rate of biodegradation of the less soluble organics tends to be very slow.

Because of their lower soil adhesion and greater biodegradability, solvents such as hexone and NPH do not generally persist in Hanford soils, whereas solvents such as carbon tetrachloride, because of higher soil interaction and low biodegradability, are generally highly persistent.

Increased volatility generally decreases the persistence of organic contaminants. Organics such as carbon tetrachloride, TCE, and chloroform are highly volatile, whereas TBP and NPH are less volatile. Volatile contaminants may be naturally removed from the vadose zone to atmosphere through "barometric pumping."

Sorption may immobilize contaminants within the vadose zone, minimizing or preventing their further migration. For radioactive contaminants, sorption may provide sufficient time for decay to reduce the concentration to negligible levels.

Oxidation-reduction reactions between contaminants and natural soil constituents can transform contaminants into less mobile or less toxic forms. For example, iron is immobile in an oxidized state, whereas chromium is immobile in a reduced state. Oxidation-reduction conditions can affect the extent and rate of breakdown of chlorinated organic contaminants.

Persistence data for radionuclides are based on their decay rates, or half-lives. Half-lives of some of the principal radionuclides are listed in Table 3-9.

3.3.1.2. Factors Affecting Contaminant Distribution. Contaminant distribution below disposal units is generally affected by the volume discharged and the type of disposal unit. The volume of liquid discharged to a waste site impacts the distribution of contaminants through its effect on the moisture content of the soil column. Discharges that maintain saturated conditions in the vadose zone result in deeper contaminant distributions. Relative volumes of waste streams, organized by waste site group, are summarized in Table 3-10 based on dates from DOE-RL 1992a, Appendix A. The type of disposal unit is also indicated for each group. Appendix G, Section G1.2.2, discusses aspects of waste site design on contaminant distribution in more detail.

The overview of waste site group characteristics provided in Table 3-10 uses a relative scale (high, medium, low). For example, a bold circle under the characteristic "volume" indicates generally high volume. Relative volume was ranked by calculating the average water volume discharged to soil column sites. In general, a volume ranking of "high" indicates greater than 2 billion L/site (500 million gal/site); a ranking of "medium" indicates between 2 billion L/site and 60 million L/site (between 500 million gal/site and 20 million gal/site); and a ranking of "low" indicates less than 60 million L/site (less than 20 million gal/site). Relative contaminant concentration was ranked primarily on the basis of radionuclide concentrations. Relative contaminant mobility was ranked based primarily on the presence of uranium or organics (Table 3-8).

The waste stream characteristics ranked in Table 3-10 also indicate general similarities among waste groups within a single category. For example, waste groups in the process condensate/process waste category tend to be low to medium volume with a high concentration of radionuclides, providing a medium to high contaminant mass. For isolation purposes, these waste groups were discharged primarily to cribs or trenches. Waste groups in the steam condensate/cooling water/chemical sewer category tend to be high volume with a low concentration of radionuclides, providing a low to medium cumulative contaminant mass. These waste groups were all discharged to ditches and ponds.

Contaminant distribution below waste disposal units is also affected by the type of disposal unit and the source of wastewater. Some generalizations with regard to these aspects are:

- Pond sites (and associated ditches) may have accumulated significant inventories of contaminants due to the large quantities of water discharged to the sites.
- Cribs generally received waste streams with somewhat higher concentrations of radionuclides for long periods of time.
- Reverse wells received smaller quantities of more contaminated wastes relative to crib waste and introduced that waste deeper into the soil column.
- Specific retention trenches and cribs were used with the intent of not saturating the soil column so that small volumes of some of the most contaminated waste streams could be discharged to the ground. Trenches and cribs tended to receive waste with higher levels of chemical constituents.
- French drains received small volumes of waste from miscellaneous nonprocess sources that had generally low concentrations of contamination.

Some of the concepts associated with the migration of contaminants in the 200 Area vadose zone are illustrated schematically in Figure 3-2. For the purposes of this discussion, two disposal scenarios are illustrated: near-surface infiltration and deep injection (through engineered or natural preferential pathways that bypass much of the vadose zone). Although intentional deep injection of contaminated liquids did occur in the 200 Areas, it was rare; near-surface infiltration was the usual disposal method.

The placement of monitoring wells relative to the waste disposal site can affect the interpretation of the contaminant distribution. For example, a well that is closer to the disposal site and relatively shallow will tend to encounter the less mobile contaminants. The least mobile contaminants may not have migrated laterally beyond the "footprint" of the disposal site or very far vertically within the vadose zone.

The degree of lateral spreading of waste water and contaminants is affected by the characteristics of the sediments: in coarser grained gravels, which typically are homogeneous and isotropic, lateral spreading tends to be minimal; in finer grained sands and silts, which typically are inhomogeneous and anisotropic, lateral spreading tends to extend further. Lateral spreading is usually most significant at contacts between coarser and finer grained layers.

3.3.1.3 Preliminary Physical Conceptual Model of the Contaminant Distribution. A generalized physical conceptual model of contaminant distribution within the 200 West and 200 East Areas, incorporating the concepts included in the individual waste group physical conceptual models (DOE-RL 1997), is presented in Figure 3-3. The vadose zone stratigraphy and a depiction of how contaminants may be distributed on the basis of typical relative mobility are illustrated separately for the 200 West Area and 200 East Area. Identifying specific information that is available or needed for each waste site group will be addressed through the DQO process that is an integral part of developing the individual group-specific work plans. The key characteristics that are used to model contaminant migration in the vadose zone and groundwater flow in the aquifer are listed for reference in separate boxes on the right-hand side of the figure.

The physical conceptual model of contaminant distribution in the 200 Area vadose zone includes the following, more specific predictions and assumptions:

- Highly mobile contaminants (tritium, I-129, and Tc-99) are believed to have already migrated to the groundwater from the waste sites for as long as active liquid waste discharge kept the intervening soil column saturated. Significant migration of these contaminants beyond the cessation of discharges (and some period of residual drainage following the cessation) is not expected unless a new and significant driving force is added at the sites.

- Lateral spreading will occur in stratified soils and where the vertical permeability is less than the horizontal permeability. However, lateral spreading of contaminants at depth is not expected to exceed 15 to 30 m beyond the facility centerline unless there is a significant impermeable zone beneath the waste site that creates a perched water condition. High-volume streams where continuous discharges or large-volume batch releases occurred favor greater lateral spreading when compared to those sites that received lower volumes of waste. The contaminant concentrations generally decrease as distance increases from the point of discharge. Although data are limited, lateral spreading is known at the 216-B-7A/7B, 216-B-57, 216-B-43/47, and 216-S-1/2 Cribs (Fecht et al. 1972).

- Maximum radionuclide contaminant concentrations are generally expected beneath the point at which the waste stream enters the soil column or waste site and decrease with depth. Typically, the highest concentrations of contaminants such as plutonium, cesium, and strontium are expected within 2 to 3 m below the point of discharge and are at near-background levels 20 m below the bottom of the waste site.

- Radionuclide contaminants generally concentrate in and just above fine-grained horizons rather than the coarser units. In general, whether in coarse or fine-grained units, the radionuclides are found to be associated with the silts and clays in the formations, which are present as 1% to 10% of the units by weight. The 200 East Area geologic units are composed of more coarse-grained units than those in the 200 West Area. The 200 West Area is further distinguished by the presence of the Plio-Pleistocene (caliche) unit, which has a much lower hydraulic conductivity than adjacent units because of the presence of calcium carbonate cemented silts, sands, and gravels. Lateral spreading is most common when facilities overlie these units.

- Downward contaminant movement may have been accelerated at several cribs by poorly sealed wells or continuous clastic dikes.

- Moderate half-life contaminants (Cs-137, Sr-90) are expected to have decayed or will decay to negligible quantities for most sites within 100 to 200 years. Shorter half-life contaminants such as Co-60, Ru-106, or tritium will decay to negligible levels in even shorter time frames.

3.3.2 Vadose and Groundwater Contamination

Completed vadose zone and groundwater characterization studies in the 200 Areas are summarized in Table 3-11 and represent the existing RI/FS data, based on laboratory analytical results. These characterization results indicate that contaminant concentrations are generally highest within approximately 6 m (20 ft) below the bottom of the waste disposal facility and that concentrations tend to decrease with depth. This document's physical conceptual model of contaminant distributions was formulated to include these specific examples of documented contaminant distributions and the general understanding of contaminant response in the Hanford soil column.

A physical conceptual model of contaminant distribution will be developed for each waste group in the group-specific work plans to describe how the contaminants are believed to be distributed within the soil column. For each waste group, the representative worst-case and typical sites will be carefully characterized to provide bounding cases for testing the conceptual model. The specific characterization plans will be determined through group-specific DQO sessions and further documented in group-specific sampling and analysis plans. The results of these detailed characterization activities will be used to further refine and strengthen the group-specific conceptual models. Prior to implementing any proposed remediation for the waste group, each site in the waste group will be characterized to confirm that it is consistent with the conceptual model for the entire waste group. Based on this confirmatory characterization, the conceptual model will be further refined or the specific waste site will be moved to a waste group with an appropriate conceptual model.

The purpose of the initial characterization of the representative waste sites and the follow-on confirmatory characterization of all of the waste sites is to ensure that any unexpected circumstances affecting contaminant distribution are investigated prior to selecting a remedial alternative. During the DQO sessions, careful consideration will be given to all contaminants of concern, including those believed to be typically less mobile, so that characterization depths and analytes are not based on broad assumptions. Thorough, specific characterization will proceed based on the consensus of the DQO participants.

The principal waste sites that have been associated with contamination of the vadose zone in the 200 Areas, as presented in the *Hanford Site Groundwater Monitoring Report for FY 1997* (Hartman and Dresel 1998), are shown in Figure 3-4. The sites shown are the subsurface disposal and storage sites with the largest contaminant inventories. The figure includes listings of the major contaminants for various groups of waste sites and an indication of each contaminant's relative mobility in the vadose zone. As indicated in the figure, special conditions may increase the relative mobility of a contaminant. In addition, if a preferential pathway is available (e.g., an open borehole or a borehole with an incomplete annular seal), relatively immobile contaminants could still be found at depth in the vadose zone. Numerous other waste sites not shown in Figure 3-4 may also have contributed to deep vadose zone contamination underlying the 200 Areas. A comprehensive list of waste sites that have impacted groundwater is not known at this time.

The contaminants that are most mobile in the vadose zone are carbon tetrachloride, chromium, cyanide, I-129, nitrate, Tc-99, H-3, and uranium. These contaminants are most likely to reach groundwater and, therefore, groundwater monitoring programs are designed to detect these constituents.

The chemical and radiological groundwater contaminant plumes for the Hanford Site are shown in Figures 3-5 and 3-6, respectively (Hartman and Dresel 1998). These figures portray the distribution of contaminants that have been detected in groundwater at concentrations exceeding the limits stated in the legend. The figures also indicate that the less mobile contaminants are not associated with groundwater plumes.

It is clear from these plume maps that contaminants from former waste disposal activities in the 200 Areas have migrated, in a dissolved phase, vapor phase, and/or separate organic liquid phase, through the vadose zone to groundwater. The widespread plumes for certain contaminants are the product of (1) past disposal practices, which involved much greater volumes of water than current waste streams, and (2) the time available since those practices ended for groundwater to disperse the contamination. It should be noted that the capacity for Hanford soils to adsorb radioactive contaminants was integral to the original design of the disposal facilities. Unanticipated production demands, which influenced volumes and characteristics of wastes, occasionally caused these facilities to receive more wastes than originally planned.

The likelihood of creating new plumes of equal magnitude to those created during the operating years is low. The absence of a mechanism to drive contaminants downward to groundwater (i.e., massive volumes of liquid waste that can saturate significant portions of the vadose zone) supports this conclusion. However, future scenarios that could result in significant amounts of new contamination reaching groundwater are plausible. These scenarios could include a catastrophic loss of liquid wastes from containment facilities; a preferential pathway through the vadose zone to groundwater, such as improperly sealed boreholes; and/or increased infiltration of moisture from the surface, which in some areas might remobilize contamination remaining in the vadose zone from former disposal activities. Increased infiltration could be caused by human activities (e.g., major water line leaks or future irrigation) and/or natural events (e.g., future climate changes).

The less mobile constituents in the vadose zone, Cs-137, Sr-90, and Pu-239/240, have each reached groundwater in the 200 Areas based on localized detections, often at single wells or associated with a 200 East Area injection well (Hartman and Dresel 1998). Because even the less mobile constituents still have a general tendency to move downward in the vadose zone, continued groundwater monitoring for their presence remains important.

Three expedited or interim response remediation activities have been undertaken in the 200 West Area to contain the existing groundwater plumes and remove contaminant mass. Soil vapor extraction has been in use since 1992 to remove carbon tetrachloride from the vadose zone at its source disposal sites to prevent further degradation of groundwater quality. Groundwater pump and treat has been in use since 1994 to remove carbon tetrachloride from the aquifer in the zone of highest dissolved carbon tetrachloride concentrations. Groundwater pump and treat has also been in use since 1994 to remove primary contaminants uranium and Tc-99 and secondary contaminants carbon tetrachloride and nitrate from the aquifer in the zone of highest dissolved uranium and Tc-99 concentrations.

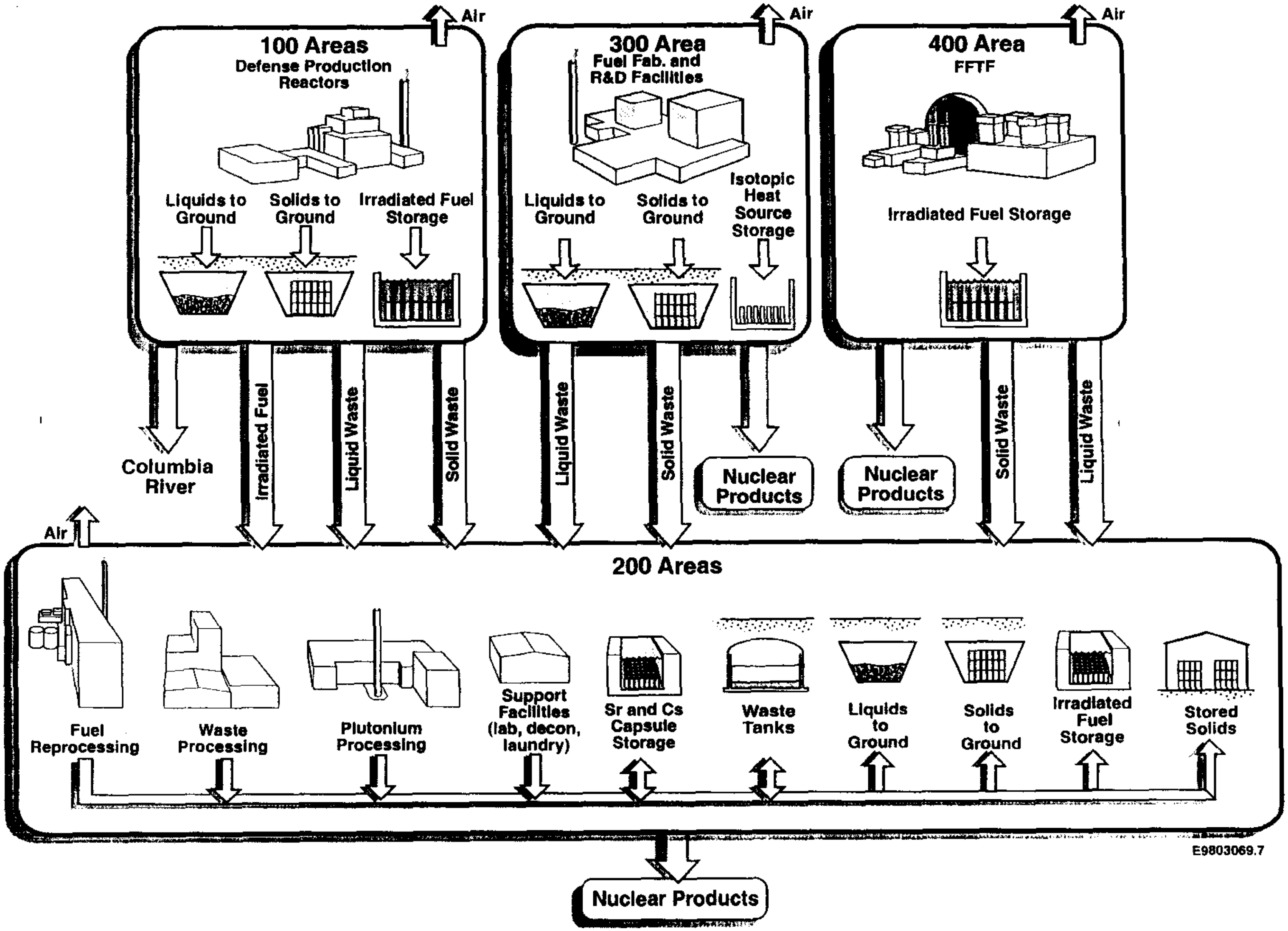


Figure 3-1. Hanford Site Radioactive Material Flow Diagram.

Figure 3-2. General Concepts of Contaminant Distribution Beneath 200 Areas Disposal Facilities.

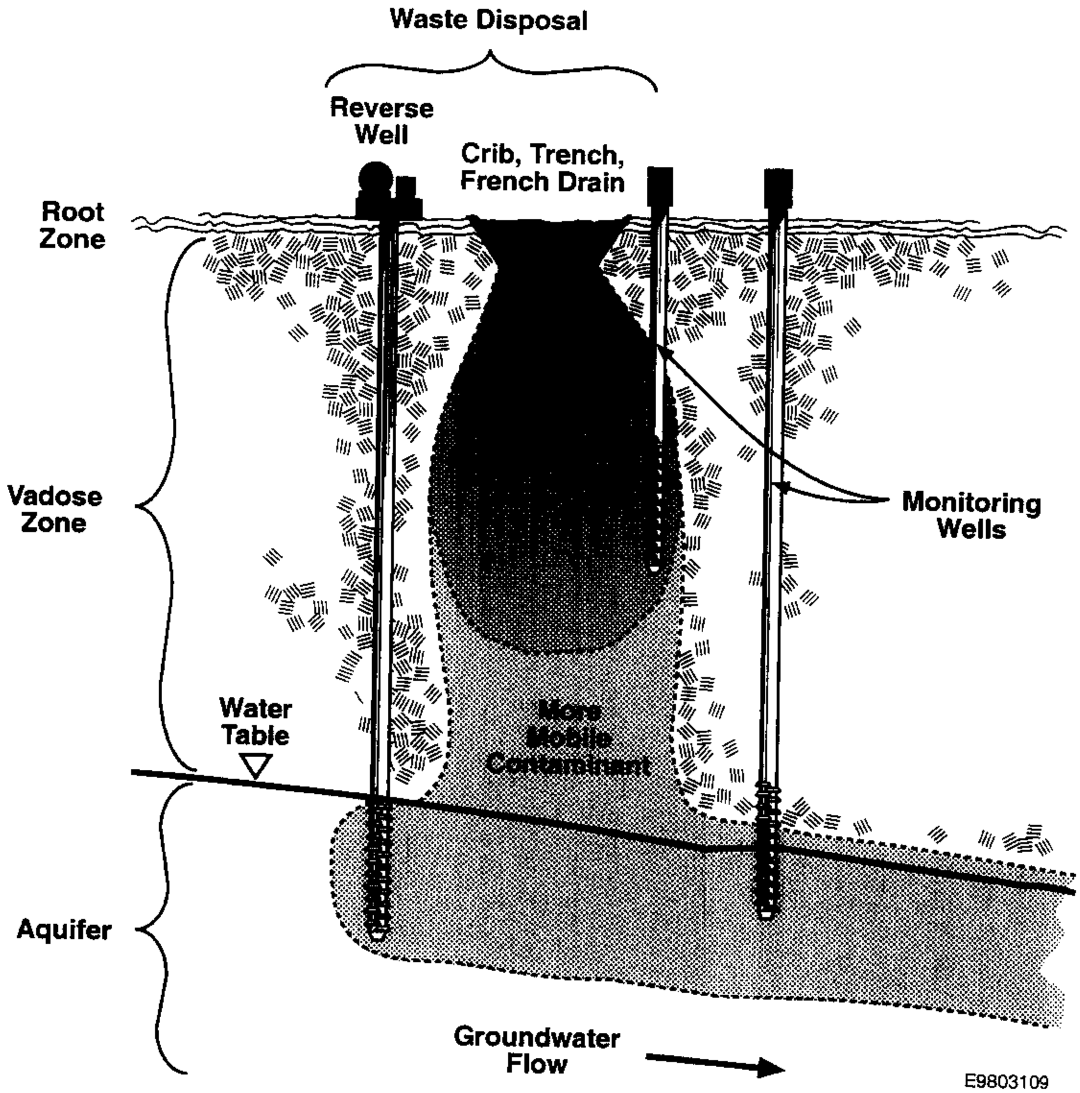
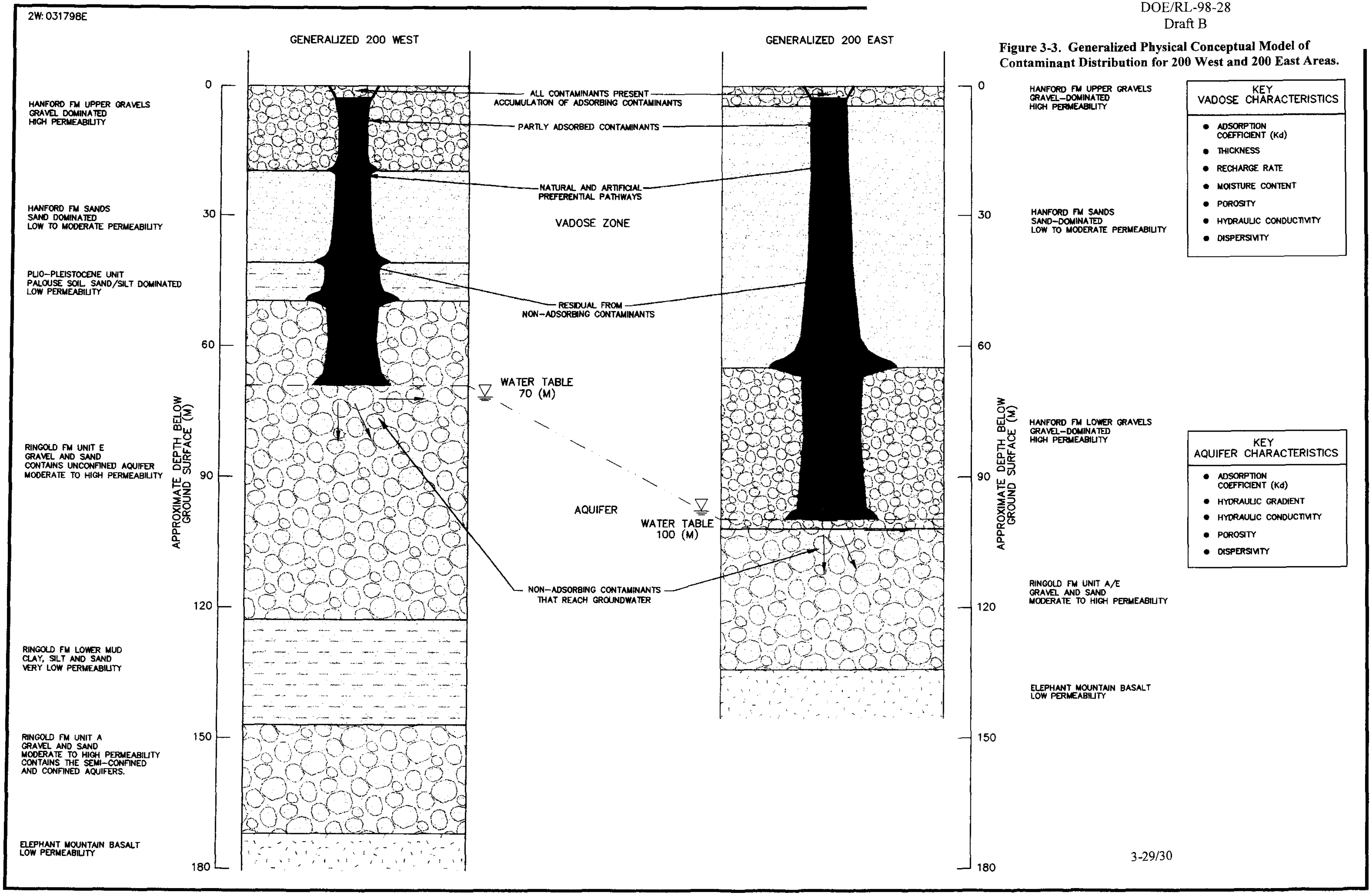
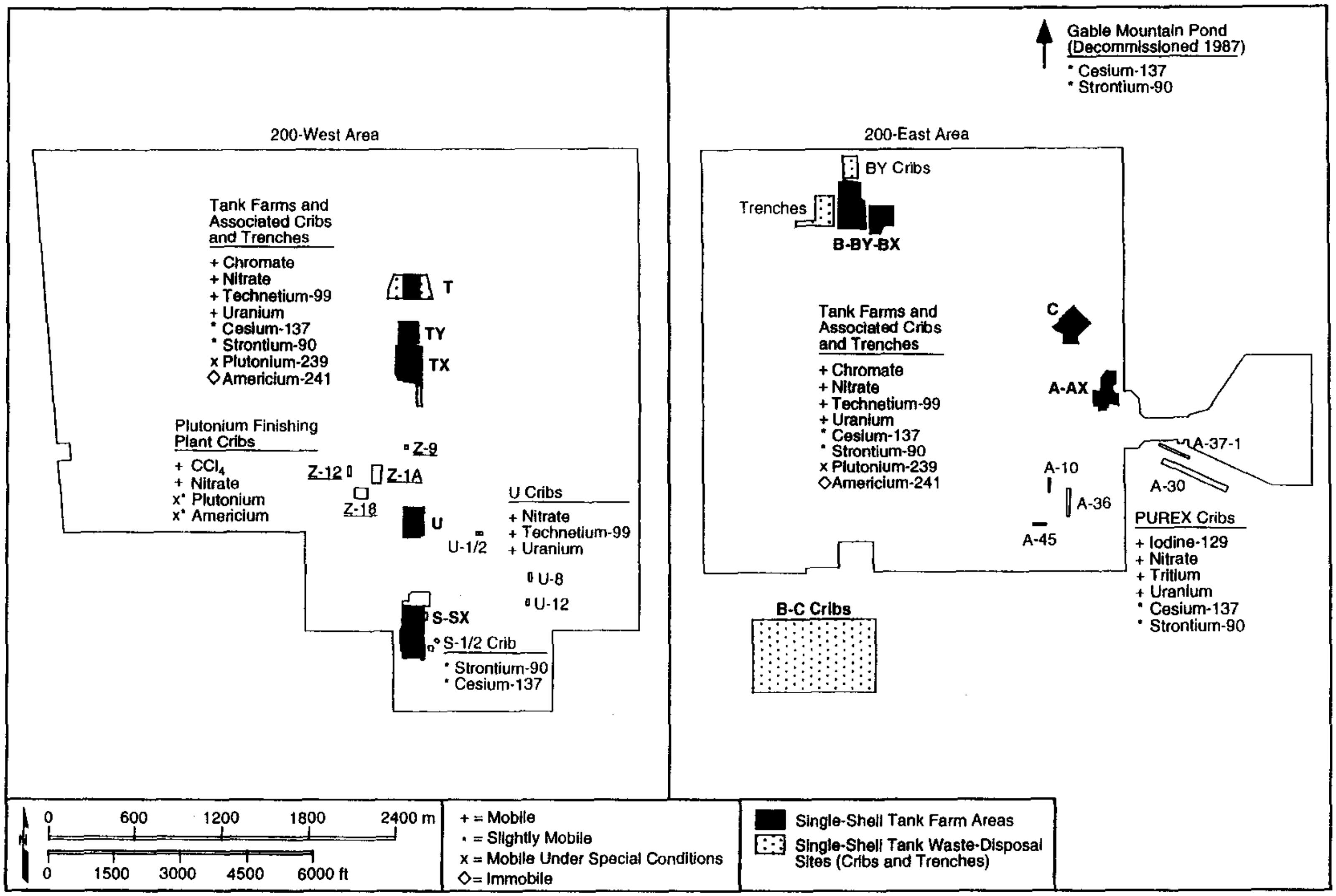


Figure 3-3. Generalized Physical Conceptual Model of Contaminant Distribution for 200 West and 200 East Areas.





E9803069.11

Figure 3-4. Major Vadose Zone Contamination Sites in the 200 Areas (from Hartman and Dresel 1998).

Figure 3-5. Distribution of Hazardous Chemical Contamination in Groundwater, Hanford Site (from Hartman and Dresel 1998).

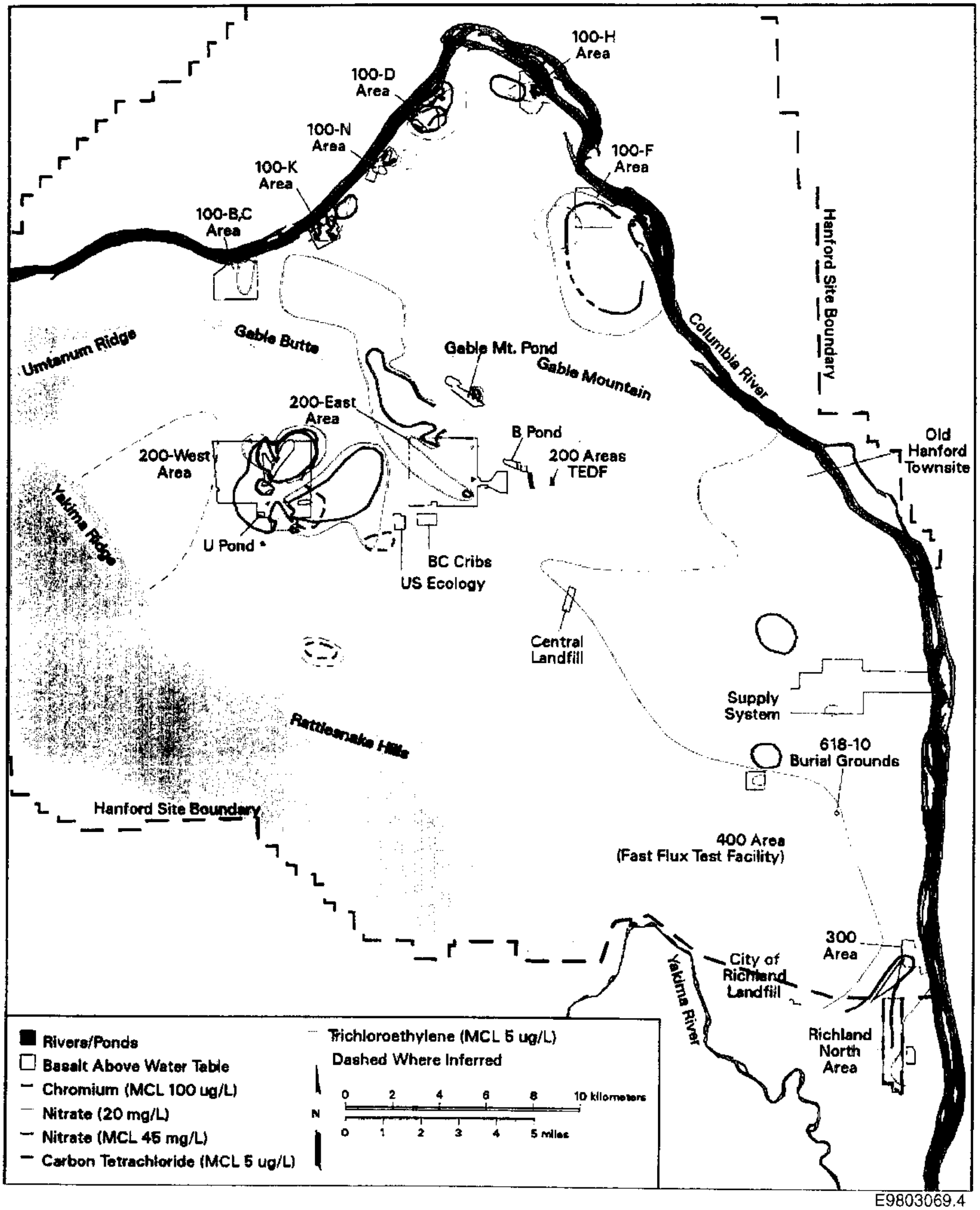


Figure 3-6. Distribution of Radionuclide Contamination in Groundwater, Hanford Site (from Hartman and Dresel 1998).

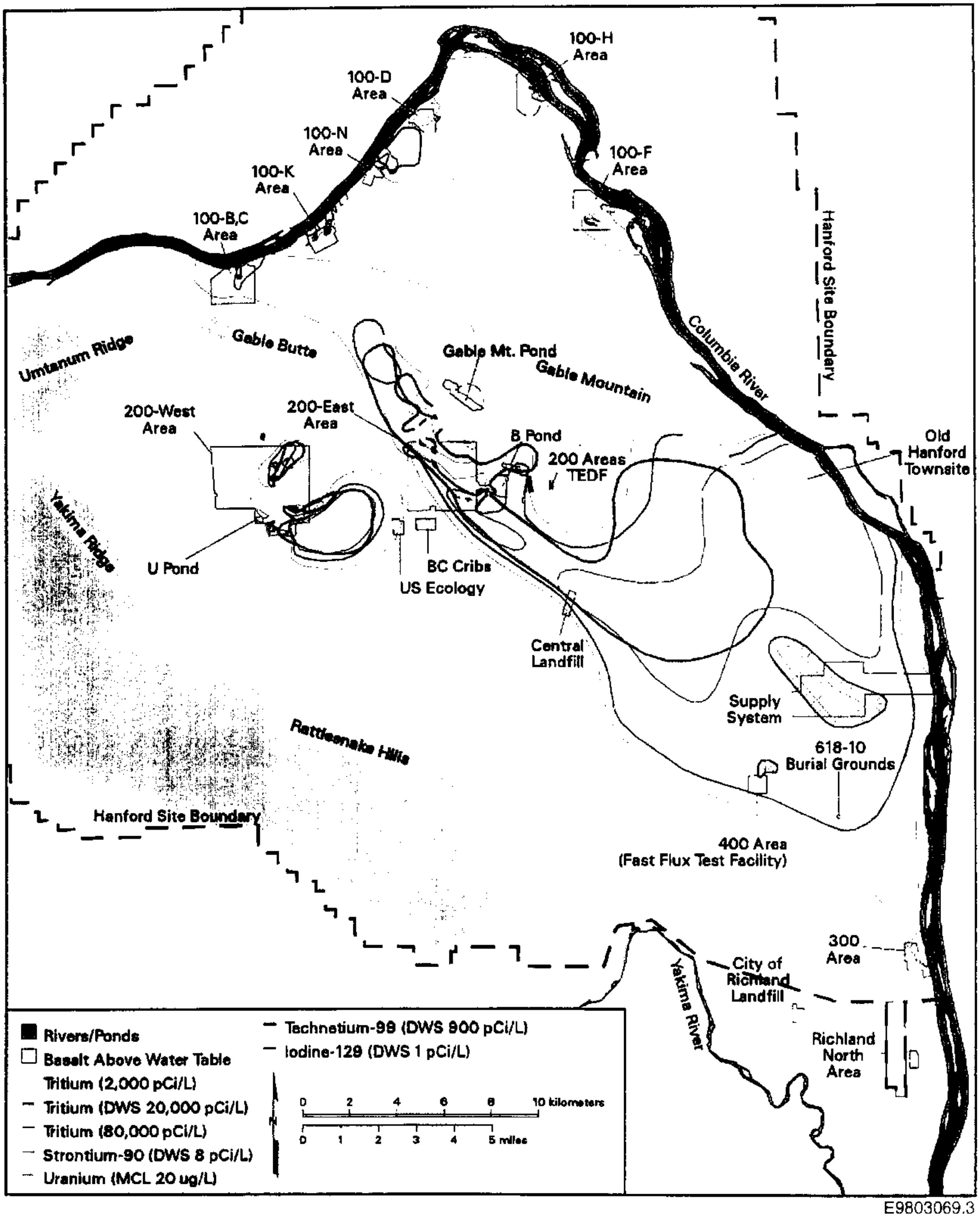


Table 3-1. Information Sources for the 200 Areas.

Source Operable Unit Area	AAMS Report	Technical Baseline Document	Technical Manual	Other
200-North	DOE/RL-92-17. (DOE-RL 1993b)	WHC-SD-EN-ES-020 (DeFord 1991)	HW-10475-C (GE 1945)	Numerous PNNL and Site Contractor Operational Groundwater and Environmental Annual Reports
T-Plant	DOE/RL-91-61 (DOE-RL 1992b)	BHI-00177 (BHI 1995d)	HW-10475-C (GE 1945)	Same
B-Plant	DOE/RL-92-05 (DOE-RL 1993d)	BHI-00179 (BHI 1995a)	HW-10475-C (GE 1945) ISO-100 (Isochem 1967)	Same
Z-Plant	DOE/RL-91-58 (DOE-RL 1992d)	BHI-00175 (BHI 1995f)	HW-10475-C (GE 1945)	Same
Semi-Works	DOE/RL-92-18, (DOE-RL 1993h)	WHC-SD-EN-ES-019 (DeFord 1992)	HW-22955, 1951 (GE 1951a)	Same
S-Plant	DOE/RL-91-60 (DOE-RL 1992a)	BHI-00176 (BHI 1995c)	HW-18700, 1951 (GE 1951d)	Same
U-Plant	DOE/RL-91-52 (DOE-RL 1992c)	BHI-00174 (BHI 1995e)	HW-19140 (GE 1951c) HW-19400, 1950 (GE 1950)	Same
PUREX	DOE/RL-92-04, (DOE-RL 1993g)	BHI-00178 (BHI 1995b)	HW-31000 (GE 1951b) RHO-MA-116 (RHO 1983)	Same
200-West Groundwater	DOE/RL-92-16 (DOE-RL 1993c)			Same
200-East Groundwater	DOE/RL-92-19 (DOE-RL 1993a)			Same

PNNL = Pacific Northwest National Laboratory
PUREX = plutonium uranium extraction process.

Table 3-2. Characterization Priorities.

Specific Criteria	Criteria Ranking
Groundwater has been impacted in the past.	Low
Groundwater is presently being impacted.	Medium
Groundwater will be impacted in the immediate future (5 to 10 years).	High
Mobile constituents (versus less mobile constituents) are present.	Medium-High
Driving forces exist that are external to the waste sites.	Low
Characterization information, including historical data, is limited or nonexistent.	Medium
The chemistry promoting contaminant migration (increasing mobility) is poorly understood.	Medium-High
Good representative sites (maximum number of sites addressed) are available.	High
Long-lived (versus short-lived) contaminants are present.	Low
Sites pose a current risk (surface threat); assumes Radiation Area Remedial Action Program provides short-term action to lower its priority.	Low
Low levels of contamination are expected over a large area.	Medium
Sites are located near perimeter of plateau/outside the 200 Area fencelines (versus inside the fenceline).	Medium
Easier (versus more difficult) to characterize and/or remediate.	High
Suitable for testing promising technologies.	Medium

(SEE TABLE 5-1, DOE-RL 1997, P. 5-2)

Table 3-3. Comparison of Technical and Administrative Prioritizations (circa 1998).

Priority Ranking	Technical Ranking (DOE-RL 1997)	Current Administrative Ranking (TPA, Milestone Change Package M-13-97-01)
1	Scavenged Waste Group	200 North Ponds Cooling Water Group
2	Chemical Sewer Group	Gable Mtn/B-Pond and Ditches Cooling Water Group
3	Plutonium/Organic-Rich Process Waste Group	Chemical Sewer Group
4	Gable Mtn/B-Pond and Ditches Cooling Water Group	U-Ponds/Z-Ditches Cooling Water Group
5	S-Pond/Ditches Cooling Water Group	Uranium-Rich Process Waste Group
6	200 North Cooling Water Group	General Process Waste Group
7	300 Areas Chemical Laboratory Waste Group	
8	T-Ponds/Ditches Cooling Water Group	
9	Miscellaneous Waste Group	
10	U-Ponds/Z-Ditches Cooling Water Group	
11	Uranium-Rich Process Waste Group	
12	Organic-Rich Process Waste Group	
13	Tank Waste Group	
14	Nonradioactive Landfills and Dumps Group	
15	Steam Condensate Group	
16	200 Areas Chemical Laboratory Waste Group	
17	Radioactive Landfills and Dumps Group	
18	General Process Waste Group	
19	Fission Product-Rich Process Waste Group	
20	Plutonium Process Waste Group	
21	Septic Tanks and Drain Fields Group	
22	Tanks/Lines/Pits/Boxes Group	
23	Unplanned Releases Group	

Table 3-4. Potential Radionuclides of Concern in the 200 Areas.

Radionuclide	Source	Comments
H-3	Neutron Activation/ Fission	
C-14	Neutron Activation	
Co-60	Neutron Activation	Approaching practical detection limits for routine analytical technologies.
Ni-63	Neutron Activation	
Sr-90	Fission	
Tc-99	Fission	
Cs-137	Fission	
Sm-151	Fission	Currently no analytical methods available for analysis
Eu-154	Fission	
Eu-155	Fission	
Th-228	Natural	Special case from thorium processing
Th-232	Natural	Special case from thorium processing
U-233	Neutron Activation	Special case from thorium processing
U-234	Natural	
U-235	Natural	
U-238	Natural	
Pu-238	Neutron Activation	
Pu-239	Neutron Activation	
Pu-240	Neutron Activation	
Pu-241	Neutron Activation	Primarily a beta emitter, routinely addressed via Am-241 (daughter) analysis
Am-241	Decay of Pu-241	

Table 3-5. Potential Inorganic Chemicals of Concern in the 200 Areas.

Analyte	Primary Source	Comments
Nitrate	All Processes	
Sulfate	All Processes	
Chloride	All Processes	
Fluoride	$BiPO_4$, PUREX , PFP, WESF	
Phosphate	$BiPO_4$, decontamination, Laundry	
Mercury	Al fuel decladding	
Lead	Shielding – all processes	
Manganese	All processes	Typically from permanganate materials
Chromium	All processes	From chromates and stainless steel corrosion
Cadmium	PUREX and 234-5 Z	Neutron poisons
Cyanide	Tank Scavenging	Added as ferrocyanides
Ammonia	PUREX and Waste Fractionizaton	
pH	All processes	Measurement of potential high corrosion due to acids or bases
Asbestos	All processes	Primarily from insulation and building materials

$BiPO_4$ = bismuth phosphate
PUREX = plutonium uranium extraction process
PFP = plutonium finishing plant process
WESF = Waste Encapsulation and Storage Facility.

Table 3-6. Potential Organic Chemicals of Concern in the 200 Areas.

Analyte	Primary Source	Comments
Kerosene range Hydrocarbons	PUREX, URP, Waste Fractionation	Covers all pure hydrocarbon-based diluents including NPH, Shell Solvent, kerosene, etc.
Tributyl Phosphate	PUREX, URP, PFP	
Carbon tetrachloride	PFP	Routine volatile organic analysis will identify and quantitate this compound
Chlorinated Solvents	Decontamination activities	Routine volatile organic analysis will identify and quantitate all potential solvents used in the 200 Areas
Hexone	REDOX	Routine volatile organic analysis will identify and quantitate this compound
PCBs	All processes	From hydraulic fluids, electrical equipment, insulation

NPH = normal paraffin hydrocarbon.
PCBs = polychlorinated biphenyls
PFP = Plutonium Finishing Plant
PUREX = Plutonium Uranium Extraction
REDOX = Reduction Oxidation
URP = Uranium Recovery Process

Table 3-7. Summary of Site Conditions That May Affect Contaminant Fate and Transport. (2 Pages) (from DOE-RL 1997)

Parameter/ Property	Representative Values/Conditions for 200 Area Sediments	General Considerations
Natural recharge	0 to 10 cm/yr via precipitation	Low annual precipitation and low precipitation intensity provides little to no recharge. Recharge may be impacted by episodic events including high-intensity rainfall events and rapid snowmelt. Evapotranspiration potential is moderate to high depending on time of year. Recharge via precipitation is affected by surface soil type, vegetation, topography, and year-to-year variations in precipitation. Gravelly surface soils with no or minor shallow-rooted vegetation facilitate recharge. Well-vegetated, fine-grained surface soils minimize recharge. Waste sites that are capped with fine-grained soils (Radiation Area Remedial Action interim-stabilized sites) or impermeable covers should have little to no net precipitation recharge or leachate generation. Granular nature of surface soils maximizes infiltration. In instances where precipitation or snow melt is sufficient to generate runoff, low-lying areas and gravelly surface soils/fill occupying may serve as collection basins for runoff and locally increase infiltration.
Vegetation	Sparse to moderate densities	Vegetation of the 200 Areas Plateau is characterized by native shrub steppe interspersed with large areas of disturbed ground with a dominant annual grass component. Associated transpiration potential is low to moderate. The vegetation in and around active ponds and ditches (riparian zone) on the 200 Areas Plateau is significantly different and higher in density than that of the surrounding dryland areas. Vegetation may remove chemicals upward in or from the soil, bring them to the surface, and subsequently introduce them to the food web. Vegetation supported by active ponds and ditches provides locally higher evapotranspiration potential and radionuclide uptake.
Soil moisture	2% to 10% by volume	At low ambient moisture contents, moisture flux is minimal and the capacity of the soil to store infiltrating liquids is high. Low soil moisture results in higher capillary forces that inhibit downward migration of water. As a result, moisture from infiltrating precipitation is retained close to the surface where it is removed by evapotranspiration. Ambient moisture contents are typically higher in finer grained sediments than in coarse-grained sediments. Contaminated pore water can be transported to groundwater by drainage under unsaturated conditions but requires an extended time frame relative to saturated conditions because hydraulic conductivities are much lower under low moisture conditions. Waste sites that received sufficient discharges to maintain localized saturated conditions in the vadose zone maximize downward pore water velocities and associated contaminant movement.
Vadose zone thickness	55 to 104 m (central plateau)	The thicker the vadose zone, the greater the potential for contaminants to interact with sediments. Vadose zone thins out from the 200 West and 200 East Areas north to Gable Gap.

Table 3-7. Summary of Site Conditions That May Affect Contaminant Fate and Transport. (2 Pages) (from DOE-RL 1997)

Parameter/ Property	Representative Values/Conditions for 200 Area Sediments	General Considerations
Soil chemistry	Alkaline pH Low oxidizing REDOX state Ion-exchange capacity dependent on contaminant and % fine-grained soil particles Very low organic carbon content, <1%	The mobility of radionuclides and other inorganic elements depends on the chemical form and charge of the element or molecule, which in turn depends on waste- and site-related factors such as the pH, REDOX state, and ionic composition. Buffering or neutralizing capacity of the soil is correlated with the calcium carbonate content of the soil. 200 Area sediments generally have carbonate contents in the range of 0.1% to 5%. Higher carbonate contents (10%) are observed within the Plio-Pleistocene caliche layer. Additional buffering capacity is provided by hydroxides of iron, aluminum, manganese, and silicon. Acidic solutions are buffered to more neutral basic pH values when contacting Hanford sediments. Many constituents/contaminants precipitate or adsorb to the soil under neutral to basic pH conditions. The vadose zone is generally an oxidizing environment. REDOX-sensitive elements from highly oxidized waste streams may become less mobile (are reduced) when contacting the vadose zone, which has a relatively lower oxidizing potential. Conversely, reduced waste streams could be oxidized when introduced into the vadose zone and thereby increase the mobility of REDOX-sensitive elements. Many contaminants of concern in 200 Area waste streams are present as cations. Sediments have sufficient cation-exchange capacity to adsorb many of these cations. Considering the substantial thickness of vadose zone (50 to 140 m), the total cation-exchange capacity of a column of soil is substantial. 200 Area sediments have a poor affinity for anions because of their negative charge. Sorption to organic components is considered to be minimal considering the low organic content. Sorption to the inorganic fraction of soils may dominate over sorption to soil organic matter. Mineralogy affects the abundance of sorption sites as well as the availability of ions for precipitation. Soil components that contribute to adsorption of inorganic compounds such as clays and organic matter are generally minor components in 200 Area sediments. Diffusion of contaminants into micropores of minerals can occur. Microorganisms in the soil may degrade organic chemicals and inorganic chemicals.
Soil texture	High sand and gravel content (~70 to 80 wt%), moderate in silt content (10 to 20 wt%), and low clay content (<1 to 10 wt%) and stratified	Coarse-grained nature of sediments generally provides for a quick-draining media. However, variations of the soil stratigraphy with depth, such as the presence of low-permeability layers, impedes the downward movement of liquids. Sediments are generally more permeable in the horizontal direction than in the vertical direction because of the stratified nature of the sediments. This facilitates the lateral spreading of liquids in the vadose zone and reduces the downward movement. Under unsaturated conditions, coarse-grained layers overlain with finer grained materials retard the movement of pore water because of the capillary barrier effect. Under saturated conditions, layers of finer grained soil such as silt layers and the Plio-Pleistocene unit function as localized aquitards. Where substantial quantities of liquid waste were disposed, perched water may form above these layers. These phenomena increase the potential for lateral movement of liquids. If perched water is laterally expansive, it can mobilize wastes beneath adjacent waste sites. Sorption to sediments increases as particle size decreases. Suspended solids/particulates in waste streams are likely to be physically filtered by the sediments at the boundary of the waste site.

REDOX = Reduction Oxidation

Table 3-8. Relative Contaminant Mobility in Hanford Soils. (2 Pages) (from DOE-RL 1997)

Contaminant	Normal Relative Mobility	Factors Affecting Mobility
Cobalt-60	Low	Highly sorbed by cation ion exchange at pH<9; readily reacts with organics and inorganic ions to form more mobile complexes (e.g., with ferrocyanide or phosphates).
Strontium-90	Moderate	Sorbs by cation ion exchange, but competes for sites with calcium. May immobilize as a coprecipitate in the mineral apatite formed by phosphate wastes. Highly mobile in acidic conditions. Mobility is increased by organics (e.g., tributyl phosphate).
Technetium-99	High	Generally present as pertechnetate anion, which is relatively nonadsorbing.
Ruthenium-106	High	Highly influenced by presence of nitrite or nitrate; short (1-year) half-life offsets high mobility.
Cesium-137	Low	Highly sorbed by cation ion exchange. Competes for sites with potassium and sodium. Mobile. Does not tend to form soluble inorganic or organic complexes. More mobile at low pH.
Uranium-238	High	Highly mobile at low pH and at pH>8 where soluble anionic carbonate complexes can form. However, uranium forms insoluble precipitates with phosphate that are highly immobile.
Plutonium-239/240	Low	Maximum sorption occurs in pH range of 4 to 8.5 as a result of formation of insoluble precipitates. Sorption is less at low pH (<4) and high pH (>8.5). Plutonium can form more mobile complexes with codisposal of organics (e.g., tributyl phosphate, hexone, dibutyl butyl phosphonate).
Americium-241	Low	Behaves similarly to plutonium.
Cadmium	Moderate to high	Mobile as a dissolved metal for most waste streams in Hanford soil column conditions.
Carbon tetrachloride	High	Used as diluent for Plutonium Finishing Plant separations processes. Not highly sorbed by Hanford soils, which are low in organic carbon content.
Chloroform	High	Degradation product of carbon tetrachloride; may be formed during chlorine treatment of potable water supplies.
Chromium	High	Generally present as an anion (chromate), which is mobile in the +6 valence state.

Table 3-8. Relative Contaminant Mobility in Hanford Soils. (2 Pages) (from DOE-RL 1997)

Contaminant	Normal Relative Mobility	Factors Affecting Mobility
Cyanide	High	Anionic species that is essentially nonadsorbing; forms complexes with cationic species, increasing their mobility.
Dibutyl butyl phosphonate	[a]	Used as a solvent with carbon tetrachloride diluent in Plutonium Finishing Plant separations process for americium-241 removal. Potential for increased mobilization of americium-241 and plutonium-239/240 due to complexation.
Hexone (methyl isobutyl ketone)	[a]	Used as solvent for plutonium and uranium in REDOX separations process. May increase radionuclide mobility due to formation of organic complexes.
Hydrazine	[a]	Strong reductant, soluble in water. Breaks down into mobile amines or ammonium ions in water.
Nitrate	High	Anionic species, nonadsorbing, considered to travel with water.
Tributyl phosphate	[a]	Used as solvent in extraction of plutonium and uranium in PUREX and Uranium Recovery Program and for plutonium in Plutonium Finishing Plant separations processes. May increase radionuclide mobility in soil column due to formation of organic complexes.
Trichloroethylene	High	Not highly sorbed by Hanford soils, which are low in organic carbon content.

Mobility factor: High = K_d 0 to 5; Moderate = K_d 5 to 100; Low = K_d >100.
K_d = soil-water distribution coefficient
[a]Organic compounds: Generally considered to be mobile due to low organic carbon content of Hanford soils.
PUREX = Plutonium Uranium Extraction
REDOX = Reduction Oxidation

Table 3-9. Radionuclides - Physical/Chemical Data.

Radionuclide	Half-Life[a] (yr)	Mode of Decay	Mobility Factors (K_d) (mL/g)	
			Neutral/Basic, Low Salt, Low Organic, Oxic Solution[b]	Neutral/Basic, High Salt, Low Organic, Oxic Solution[c]
Cobalt-60	5.27	Gamma	1,200 - 12,500	222 - 4,760
Strontium-90	29.1	Beta	5 -173	0.3 - 42
Technetium-99	2.13×10^5	Beta	0 - 1.3	0 - 0.01
Ruthenium-106	1.02	Beta	27 - 274	0 - 10
Cesium-137	30.2	Gamma	540 - 3,180	64 - 1,360
Uranium-238	4.47×10^9	Alpha	0.08 - 79.3	0 - 4
Plutonium-239/240	2.41×10^4	Alpha	80 - >1,980	10 - >98
Americium-241	432.7	Alpha	67 - >1,200	280 - >1,200

[a]Walker et al. (1989).
[b]Kaplan et al. (1995), Table 6.1.
[c]Kaplan et al. (1995), Table 6.3.

Table 3-10. General Characteristics of Waste Streams and Waste Site Groups.

CATEGORY	LIQUID WASTE (Relative Scale: **O** = high, O = medium, o = low)					SOLID WASTE	RECEIVING SITE				
GROUP	VOLUME	CONTAMINANT CONCENTRATION	CONTAMINANT MASS	CONTAMINANT MOBILITY	GROUNDWATER PLUME?		POND, DITCH	TRENCH	CRIB, FRENCH DRAIN	REVERSE WELL	BURIAL GROUND
I. Process Condensate/ Process											
a. U-rich	O	**O**	**O**	**O**	Y				x		
b. Pu-rich	o	**O**	O	o					x		
c. Pu-organic rich	O	**O**	**O**	**O**	Y				x		
d. Organic-rich	O	**O**	**O**	**O**					x		
e. Fission product-rich	O	o	o	o					x		
f. General	o	o	o	o					x		
II. Steam Condensate/Cooling											
a. Steam Condensate	**O**	O	O	O			x				
b. Chemical Sewer	**O**	o ?	o ?	**O** ?	?		x				
c. U-Pond/Z-Ditches	**O**	O	O	O	Y		x				
d. Gable Mt/B-Pond	**O**	O	O	O	Y		x				
e. 200 North Ponds	O	o	o	o			x				
f. S-Ponds and Ditches	**O**	O	O	**O**	Y		x				
g. T-Pond and Ditches	**O**	o	O	O			x				
III. Chemical Waste											
a. 200 Area	O	O	O	O					x		
b. 300 Area	o	O	o	O					x		
IV. Miscellaneous	o	o	o	o					x		
V. Tank/Scavenged											
a. Tank	o	**O**	**O**	O	Y			x	x		
b. Scavenged	o	**O**	**O**	**O**	Y			x	x		
VI. Tanks/Lines/Pits/Boxes	o	**O**		O					x		
VII. Unplanned Releases	o	o - **O**	O	o			x				
VIII. Septic Tanks and Drain	o	o	o	o					x		
IX. Landfills and Dumps											
a. Radioactive						X					x
b. Nonradioactive						X					x

Table 3-11. Results of Vadose Zone Characterization Studies in the 200 Areas. (2 Sheets)

BACKGROUND INFORMATION								
Waste Site Name	200-BP-1 OU (216-B-43-B-50, 216-B-57, 216-B-61)	218-E-8 Borrow Pit Demolition Site	200 West Ash Pit Demolition Site	216-B-3/-3A/-3B/-3C	2101-M Pond	216-U-4/U-4A	216-U-12	216-U-8
Waste Group	Scavenged Waste Group, Fission Product-Rich Group (200-TW-1)	Non-Radioactive Landfills and Dumps Group (200-SW-1)	Non-Radioactive Landfills and Dumps Group (200-SW-1)	Gable Mtn/B-Pond & Ditches Cooling Water Group (200-CW-1)	200 Area Chemical Laboratory Waste Group (200-LW-2)	200 Area Chemical Laboratory Waste Group (200-LW-2)	Uranium-Rich Process Condensate/Process Waste Group (200-PW-2)	Uranium-Rich Process Condensate/Process Waste Group (200-PW-2)
Site Type	Cribs	Burial Ground/ Detonation Site	Coal Ash Pit/ Detonation Site	Ponds	Pond (U – Shaped)	Reverse Well/French Drain	Crib	Crib (wood and gravel)
Bottom Dimensions of Structure and Depth	9.1m x 9.1 m x 4.3 m (30 ft x 30 ft x 14 ft)	6.3 m x 6.3 m (20 ft x 20 ft)	6.3 m x 6.3 m (20 ft x 20 ft)	161,875 m^2, 40,470 m^2, 40,470 m^2, 165,900 m^2	64 m. x 21.3 m. x 2.7 m (210 ft x 70 ft x 9 ft)	7.6 cm x 22.9 m/1.3 m x 3.1 m (3" x 75')/ (4.25' x 10')	30.5 m x 3.1 m x 4.6 m (100 ft x 10 ft x 15 ft)	48.8 m x 15.3 m x 10.3 m (150 ft x 50 ft x 31 ft)
Dates of Operation	1954-1957, 1965-1974, NA	1984	1984-86	1945-1994, 1983-1995, 1983-1995, 1985-1997	1960's-1988	1947-1955/1955-1970	1960-1988	1952-1960
Major Potential Contaminants	Uranium, fission products and other radionuclides.	VOAs, SVOAs	VOAs, SVOAs	Pesticides, VOAs, SVOAs, metals	Metals	Fission products, uranium, plutonium	Total uranium, fission products, pH, $CaCO_3$, nitrate	Uranium, fission products and other radionuclides
Additional Potential Contaminants Likely	Yes. Cyanide, Nitrates and hazardous waste constituents possible.	Yes. Other hazardous waste constituents possible.	Yes. Other hazardous waste constituents possible.	Yes. Other hazardous waste constituents possible.	Yes. Other hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.
Vertical Extent of Contamination Expected	Surface, vadose zone and groundwater	Surface	Surface	Vadose zone	Vadose zone and groundwater	Shallow vadose zone at french drain. Moderately deep in vadose zone at reverse well.	Vadose zone to groundwater	Vadose zone to caliche layer
Horizontal Extent of Contamination Expected	Moderate lateral spreading	Limited	Limited	Potential for lateral spreading	Limited	Limited	Potential for lateral spreading	Some lateral spreading possible on caliche layer.
Preliminary Conceptual Model	Yes.	Yes.	Yes	Yes.	Yes	Yes.	Yes.	Yes.
CHARACTERIZATION OBJECTIVES AND PLANNING								
Date of Latest Investigation	1990-1993	1994	1994	1989, 1991, 1992	1988, 1991	1994	1994	1994
Program	CERCLA	RCRA	RCRA	RCRA	RCRA	CERCLA	RCRA/CERCLA	CERCLA
Investigation Type	Vadose zone and groundwater	Vadose zone	Vadose zone	Vadose zone	Vadose zone and groundwater	Vadose zone	Vadose zone	Vadose zone
Primary Objective(s)	- Determine contamination types and vertical/lateral extent. - Determine radionuclides in unconfined and confined aquifers.	- Verify absence of hazardous materials in soil column.	- Verify absence of hazardous materials in soil column.	-Verify absence of hazardous materials in soil column	- Verify absence of hazardous materials in soil column.	- Determine vertical distribution of contamination in soil column.	- Determine vertical distribution of contamination in soil column. - Evaluate a limited RCRA contamination of concern suite	- Determine vertical distribution of contamination in soil column.
INVESTIGATION APPROACH								
Surface Samples/Test Pits	None	10 Surface Samples	8 Surface Samples	Phase 1, 1989 – Shallow Pond Bottom Sampling, All B-3 Ponds Phase 2, 1992 – Shallow Pond Bottom Sampling in B-3 lobes.	Multiple Pond-bottom samples	1 Surface Sample	None	Surface Samples
No. of Boreholes Planned in Waste Unit	25 – 3 through each active crib, to depths of 30 ft and 1 in inactive crib. Three extended to depths of 70 m (230 ft).	None	None	Phase 3, 1991 – Upper vadose zone boreholes, 81-142 ft deep	4 shallow (5 m.) boreholes into pond bottom + 4 remote background samples	1, in radiation area between the reverse well and french drain.	None	1 – Close to first wooden crib
No. of Boreholes Planned Adjacent to Waste Unit	6 each, 15.2 cm (6 in. dia.), 50-ft deep driven holes at 2 waste sites, used with RLS.	None	None	None.	4 wells, to groundwater	None	1	None
No. of Cone Penetrometer Pushes Planned	None	None	None	None.	None	None	None	None
No. of Groundwater Monitoring Wells Planned	7 to upper unconfined aquifer, 3 to first confined aquifer	None	None	None.	4 wells	None	None	None
Geophysical Logging	17 new boreholes w gamma spec. 10 old boreholes w/ gamma spec. 10-12 "adj." holes with RLS.	None	None	Yes. Gross gamma logging.	Yes.	Yes. RLS logging	Yes, RLS logging	Yes. RLS logging
GENERAL CONCLUSION								
	1. Radiological contamination concentrated within crib gravels and within the first 15 ft beneath crib bottom. 2. RLS log showed contaminants to reach 50 to70 ft below crib. Trace contamination detected at 215 ft (i.e., ~GW) below crib. 3. Lateral spreading observed locally at about 50 ft below B-57 crib.	1. No unacceptable levels of inorganic or organic contaminants in soil. 2. Site clean closed	1. 1. No unacceptable levels of inorganic or organic contaminants in soil. 2. Site clean closed.	1. VOAs, SVOAs, metals, pesticides, & PCBs were not found in vadose zone. Sites were clean closed. 2. Radiological contaminants present in ρCi/g quantities throughout soil column. No obvious concentration gradients with depth.	1. No unacceptable inorganic or organic contaminants in soil samples. 2. Site clean closed.	1. Most contamination concentrated 6-7 ft below bottom of french drain and up to 25 ft below the 75 ft deep reverse well. 2. Near-background levels of contamination observed below 100 ft.	1. Background levels of contaminants indicate limited lateral spreading in vadose zone 3 m beneath crib bottom.	1. Most contamination found directly beneath crib and to a depth 20 ft below crib bottom. 2. Minor increases in U concentrations above background noted at top of caliche layer. 3. No lateral spreading in soil column below vadose zone. Lateral spreading at top of caliche layer.

Table 3-11. Results of Vadose Zone Characterization Studies in the 200 Areas. (2 Sheets)

BACKGROUND INFORMATION					
Waste Site Name	216-U-10 Pond	216-U-14 Ditch	216-B-2-2 Ditch	216-T-1 Ditch	216-U-1/U-2 Crib
Waste Group	U-Pond//Z-Ditches Cooling Water Group (200-CW-1)	U-Pond/Z-Ditches Cooling Water Group (200-CW-1)	Gable Pond/B-Ponds and Ditches Cooling Water Group (200-CW-1)	T-Pond and Ditches Cooling Water Group (200-CW-4)	Uranium-Rich Process Condensate/Process Waste Group (200-PW-2)
Site Type	Infiltration pond	5860 ft long unlined infiltration ditch.	3,500 ft long unlined infiltration ditch.	1,800 ft long unlined infiltration ditch.	Buried crib.
Bottom of Structure	6.5 ft below ground surface (BGS)	Bottom of structure is 0 to 9 ft below the existing surface.	6-8 ft BGS.	10 ft BGS.	~25 ft BGS
Dates of Operation	1944 -1985	1944 –1995	1963-1970	1944-1995	1951-1967
Suspected Contaminants	Uranium and other radionuclides	Uranium and other radionuclides	Strontium and other radionuclides	Uranium and other radionuclides	Uranium and the radionuclides
Additional Contaminants Likely	Yes. Hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.	Yes. Hazardous waste constituents possible.	Radionuclides are primary contaminants of interests.
Vertical Extent of Contamination Expected	Contaminants may extend to groundwater.	Contaminants may extend to groundwater.	Near surface contamination expected. This is an issue of dispute.	Near surface contamination expected.	Contaminants may extend to groundwater.
Horizontal Extent of Contamination Expected.	Limited	Limited	Limited	Limited	Some lateral spreading has been observed on the caliche layer.
Preliminary Conceptual Model	Yes.	Yes.	Yes.	Yes.	Yes.
CHARACTERIZATION ACTIVITIES AND PLANNING					
Date of Latest Investigation	1994	1994	1998	1995	1994
Program	CERCLA	OPERATIONS	CERCLA	OPERATIONS	CERCLA
Investigation Type	Vadose	Vadose and groundwater	Vadose	Vadose and groundwater	Vadose zone to caliche layer
Primary Objective(s):	1. Determine vertical extent and type of contamination beneath pond. 2. Determine if high concentration of contaminants are in deep zone.	1. Determine vertical extent and type of contamination beneath ditch. 2. Determine horizontal and type of contamination adjacent to ditch. 3. Determine contaminant impact on groundwater. 4. Determine hydrologic impact on groundwater.	1. Determine the vertical extent and type of contamination beneath the ditch .	1. Determine vertical extent and type of contamination beneath ditch.. 2. Determine horizontal and type of contamination adjacent to ditch. 3. Determine contaminant impact on groundwater. 4. Determine hydrologic impact on groundwater.	1. Determine vertical extent of radiological contamination beneath crib. 2. Determine horizontal extent radiological contamination adjacent to crib. 3. Determine if high concentration of contaminants are in deep zone.
INVESTIGATION APPROACH					
Test Pits	1 Test Pit.	6 Test Pits.	None.	3 Test Pits.	NA
No of Boreholes Planned in Waste Unit	1 Borehole.	None.	1 Borehole.	None.	1 Borehole
No. of Boreholes Planned Adjacent to Waste Unit	None.	3 Boreholes.	None.	None.	2 Boreholes
No. of Cone Penetrometer Planned	10 cone penetrometer.	None.	None.	None.	None .
No. of Groundwater Monitoring Well Planned	None.	3 Monitoring Wells	None.	1 Monitoring well.	None.
Geophysical Logging	Yes.	Yes.	Yes.	Yes.	Yes.
GENERAL CONCLUSIONS					
	1. The highest level of contamination is detected within several feet of the bottom of the pond. 2. Contaminant levels generally decrease with depth. 3. The vertical extent of significant contamination appears to be limited. 4. Additional characterization is not needed. 5. Remedial action not required at this time.	1. The highest level of contamination is detected within several feet of the bottom of the ditch. 2. Contaminant levels generally decrease with depth. 3. Elevated levels of contamination are detected associated with the caliche layer. 4. Contaminant transport is principally vertically down beneath the facility. 5. Clastic dikes may transport contaminants preferentially. 6. Additional characterization is not needed.	1. The highest level of contamination is detected within 8 ft of the bottom of the ditch. 2. Contaminant levels fall off rapidly with depth. 3. The vertical extent of significant contamination appears to be limited. 4. Additional characterization is needed.	1. The highest level of contamination is detected within several feet of the bottom of the ditch. 2. Contaminant levels generally decrease with depth. 3. The vertical extent of significant contamination appears to be limited. 4. Contaminant transport is principally vertically down beneath the facility. 5. Additional characterization is not needed.	1. The highest level of contamination is detected within a 20-ft zone beneath the crib. 2. Contaminant levels generally decrease with depth. 3. Contaminant transport is principally vertically down beneath the facility. 4. Low concentrations of uranium contamination are detected associated with the caliche layer. Some lateral spreading on the caliche layer has occurred. 5. Additional characterization is not needed. 6. Remedial action not required at this time.

4.0 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

4.1 INTRODUCTION

This section identifies and evaluates potential ARARs for characterization and remediation activities at 200 Area waste sites. It is intended to capture the major ARARs for all reasonably conceivable activities, but at a more generic level of detail than will occur in the future at the group-specific level. Future group-specific FSs will use this information to further refine ARARs that are pertinent to the remedial alternatives under consideration at each waste site group. ARARs identified in this document have also been used to form the basis for the levels to which contaminants must be cleaned up to be protective of human health and the environment (see Section 5.0, "Conceptual Exposure Model and Risk Assessment").

Because all 200 Area waste sites will be the subject of a CERCLA decision document, all remedial and corrective actions will be required to meet ARARs (see Section 2.2.2). Only the substantive requirements (e.g., use of control/containment equipment, compliance with numerical standards) associated with ARARs apply to CERCLA onsite activities. ARARs associated with administrative requirements, such as permitting, are not applicable to CERCLA onsite activities. This CERCLA permitting exemption will be extended to all CERCLA activities as well as those associated with RCRA corrective action units and TSD units, with the exception that RCRA units will be incorporated into the Hanford Facility RCRA Permit.

The ARAR identification process is based on CERCLA guidance (EPA 1988, 1989a). Final ARARs for remediation will be established in the ROD. Section 121 of CERCLA, as amended, establishes cleanup standards for remedial actions at NPL sites. Section 121 requires, in part, that any applicable or relevant and appropriate standard, requirement, criteria, or limitation under any federal environmental law, or any more stringent state requirement promulgated pursuant to a state environmental statute, be met for any dangerous substance, pollutant, or contaminant that will remain on site after completion of remedial action. The EPA has interpreted the ARAR selection process to apply to all aspects of remedial actions, not just those related to contaminants left in place after completion of those remedial actions.

Potential ARARs are classified into one of three categories: chemical-specific, location-specific, and action-specific. These categories are defined as follows:

- Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of public and worker safety levels and site cleanup levels.

- Location-specific requirements are restrictions placed on the concentration of dangerous substances or the conduct of activities solely because they occur in special geographic areas.

- Action-specific requirements are usually technology- or activity-based requirements or limitations triggered by the remedial actions performed at the site.

When requirements in each of these categories are identified, a determination must be made as to whether those requirements are applicable or relevant and appropriate. A requirement is applicable if the specific terms (or jurisdictional prerequisites) of the law or regulations directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if (1) circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirement, and (2) the requirement's use is well suited to the site.

To-be-considered (TBC) information is nonpromulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. In some circumstances, TBCs will be considered along with ARARs in determining the remedial action necessary for protection of human health and the environment. TBCs complement ARARs in determining what is protective at a site or how certain actions should be implemented. For example, because drinking water MCLs do not exist for all contaminants, drinking water health advisories, which would be TBCs, may be helpful in defining appropriate remedial action goals.

4.2 WAIVERS FROM ARARS

The EPA may waive ARARs and select a remedial action that does not attain the same level of cleanup as that identified by the ARARs. Section 121 of the *Superfund Amendments and Reauthorization Act* identifies six circumstances in which the EPA may waive ARARs for onsite remedial actions. The six circumstances are as follows:

- The remedial action selected is only a part of a total remedial action (such as an interim action), and the final remedy will attain the ARAR upon its completion.
- Compliance with the ARAR will result in a greater risk to human health and the environment than alternative options.
- Compliance with the ARAR is technically impracticable from an engineering perspective.
- An alternative remedial action will attain an equivalent standard of performance through the use of another method or approach.
- The ARAR is a state requirement that the state has not consistently applied (or demonstrated the intent to apply consistently) in similar circumstances.
- In the case of Section 104 (Superfund-financed remedial actions), compliance with the ARAR will not provide a balance between protecting human health and the environment and the availability of Superfund money for response at other facilities.

4.3 ARARS APPLICABLE TO 200 AREA REMEDIAL ACTIONS

Potential federal and state ARARs are presented in Tables 4-1 and 4-2, respectively. Detailed evaluation and possible modification to these potential ARARs will occur during the FS phase of the RI/FS process for individual waste groups in the 200 Areas.

The chemical-specific ARARs and TBCs likely to be most pertinent to remediation of the 200 Area waste sites are the State of Washington MTCA regulations and EPA's memorandum entitled *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* (EPA 1997a). MTCA and the EPA memorandum help establish soil cleanup standards for nonradioactive and radioactive contaminants at waste sites. The *Safe Drinking Water Act,* National Primary/Secondary Drinking Water Standards, *Clean Water Act* Water Quality Standards, and state Surface Water Quality Standards are also likely to be pertinent in determining whether waste site remediation is protective of groundwater and the Columbia River. The several federal and state air emission standards are likely to be important in air emission limits and control requirements for any remedial actions that produce air emissions. RCRA land disposal restrictions will be important standards during the management of wastes generated during remedial actions.

Location-specific ARARs potentially pertinent to remediation of 200 Area waste sites include the *National Historic Preservation Act* and the *Archeological and Historic Preservation Act*, which might require protective measures during characterization and remediation.

Action-specific ARARs that could be pertinent to 200 Area remediation are state solid and dangerous waste regulations (for management of characterization and remediation wastes and performance standards for waste left in place), *Atomic Energy Act* regulations (for performance standards for radioactive waste sites), and federal and state regulations related to air emissions.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
CHEMICAL-SPECIFIC			
Safe Drinking Water Act of 1974, 42 USC 300, et seq.			
National Primary Drinking Water Standards, 40 CFR 141	ARAR	Establishes maximum contaminant levels (MCLs) that are drinking water criteria designed to protect human health from the potential adverse effects of contaminants in drinking water .	Groundwater in the 200 Areas is not currently used for drinking water, but it could be used in the future, if the site is released from institutional controls. In addition, groundwater in the 200 Areas is hydraulically connected to groundwater that is used for drinking water and to the Columbia River. Remedial alternatives need to ensure that migration of waste site contaminants to groundwater do not cause the groundwater to exceed MCLs and non-zero MCLGs pursuant to State MTCA requirements contained in WAC 173-340-720.
National Secondary Drinking Water Standards, 40 CFR 143	ARAR/State	Establishes secondary drinking water standards for use in establishing cleanup levels.	Federal secondary standards are not enforceable standards and are not typically applicable or relevant and appropriate requirements; however, the State of Washington Model Toxics Control Act requires that these standards be considered in establishing cleanup levels protective of groundwater.
Clean Water Act of 1977, 33 USC 1251, as amended			
Designation of Hazardous Substances, 40 CFR 116	ARAR	Designates hazardous substances in Tables 116.4A and 116.4B of the regulation. These are included in the CERCLA list of hazardous substances.	Hazardous substances are present in the 200 Areas.
Water Quality Standards, 40 CFR 131	ARAR	Establishes the requirements and procedures for states to develop and adopt water quality standards based on federal water quality criteria that are at least as stringent as the federal standards. 40 CFR 131 provides EPA the authority to review and approve state water quality standards. Washington State has received EPA approval and has adopted more stringent water quality criteria under WAC 173-201A. These criteria are presented in detail as state chemical-specific ARARs.	Cleanup must ensure protection of surface water (the Columbia River) from soil contamination in the 200 Areas.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Atomic Energy Act of 1954, as amended, 42 USC 2011, et seq.			
Environmental Radiation Protection Standards for Nuclear Power Operations, 40 CFR 190	ARAR	Specifies the levels below which normal operations of the uranium fuel cycle are determined to be environmentally acceptable. The standard sets dose equivalents from the facility that are not to exceed 25 mrem/yr to whole body, 75 mrem/yr to thyroid, or 25 mrem/yr to any other organ.	These standards are not applicable since the standard excludes operations at disposal sites and uses a definition of the uranium fuel cycle that focuses on those processes that result in generation of electrical power. However, the standards are relevant and appropriate because they address acceptable dose to the public as a result of planned discharges similar to past activities conducted in the 200 Areas.
Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste, 40 CFR 191	ARAR	Establishes standards for management and disposal of spent nuclear fuel, high-level waste, and transuranic wastes at facilities operated by the DOE. The standard addresses all disposal methods. Subpart A applies to facilities regulated by the NRC and sets maximum committed effective dose of 15 mrem/yr for any member of the public. Environmental standards set in Subpart B address protection of individual members of the public and groundwater at certain disposal facilities.	The requirements are potentially relevant and appropriate because transuranic wastes may be generated at 200 Area waste sites.
Nuclear Regulatory Standards for Protection Against Radiation, 10 CFR 20	ARAR	The regulation establishes standards for protection of the public against radiation arising from the use of regulated materials. Remedial alternatives need to limit external and internal exposure from releases to levels that do not exceed 100 mrem/yr, or 2 mrem/hr from external exposure in unrestricted areas. These requirements also establish criteria for closing NRC-licensed sites, including a soil remediation standard of 25 mrem/yr.	The regulation establishes standards for protection of the public against radiation arising from the use of regulated materials and as such are relevant and appropriate. Radioactive material from sources not licensed by the NRC are not subject to these regulations; therefore, this standard is not applicable because the Hanford operations are not NRC licensed.
EPA Memorandum, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER No. 9200.4-18	To be considered	This memorandum provides guidance on cleanup levels at CERCLA sites. EPA has determined in this directive that dose limits established by the NRC in 40 CFR 196 (25 mrem/yr) are generally not protective at CERCLA sites and instead states that a cleanup level of 15 mrem/yr is protective of human health and the environment. EPA dose limits are to generally achieve risk levels in the 10^{-4} to 10^{-6} risk range.	This memorandum, although a TBC, is considered by EPA to be more protective than NRC standards; therefore, it will be considered for use at 200 Area remedial actions.
Resource Conservation and Recovery Act, 42 USC 6901, et seq.			
Criteria for Classification of Solid Waste Disposal Facilities and Practices, 40 CFR 257	ARAR	Criteria specified under this standard are used to determine which solid waste disposal facilities and practices pose a reasonable possibility of adverse risk to human health and the environment.	This standard is applicable to remedial actions since the 200 Areas contain solid waste disposal facilities.
Identification and Listing of Wastes, 40 CFR 261	ARAR	This part establishes the framework for determining whether a waste is hazardous. Treatment wastes should be tested using methods established under this section.	These requirements are applicable because hazardous waste may be generated during 200 Area remedial actions.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Ground Water Protection Standards, 40 CFR 264.92	ARAR	Three remediation levels of groundwater protection established by this section are background, MCLs, and ACLs. MCLs are set at the same levels as SDWA MCLs, and where no SDWA MCL has been set, health-based ACLs may be established that are protective of human health and environment.	Groundwater restoration goals established by this section are relevant and appropriate to the establishment of soil cleanup levels protective of groundwater.
Corrective Action for Solid Waste Management Units. 40 CFR 264, Subpart S (proposed)	To be considered	Identifies chemical-specific soil cleanup levels that are protective of groundwater. Proposed standards are based on ensuring groundwater protected to MCLs where available.	Groundwater restoration goals established by this section are relevant and appropriate to the establishment of soil cleanup levels protective of groundwater. Because this is a proposed rule, it is to be considered at this time.
Land Disposal Restrictions, 40 CFR 268	ARAR	This section of the hazardous waste regulations prohibits disposal of restricted wastes unless treatment standards have been met.	This section is applicable to the treatment and disposal of RCRA hazardous waste from 200 Areas sites. If remediation occurs as a RCRA Subpart S CAMU, land disposal restrictions would not apply.
Clean Air Act, as amended, 42 USC 7401, et seq.			
National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61	ARAR	Establishes emission standards for hazardous air pollutants including radionuclides, other than radon, and asbestos. Subpart H sets emission limits from the entire facility to ambient air that are not to cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. The definition of facility includes all buildings, structures, and operations at one contiguous site. The requirements also set standards to ensure that emissions from asbestos are minimized during collection, processing, packaging, and transportation.	These requirements are applicable to the site because the potential to release radioactive contaminants to unrestricted areas exists. Also, asbestos waste may be generated during cleanup activities.
Uranium Mill Tailings Radiation Control Act of 1978, 42 USC 2022			
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 CFR 192	ARAR	Subpart B sets groundwater protection requirements for concentrations of radium-226, radium-228, and gross alpha particle activity at EPA-established levels for drinking water, 5 pCi/L for radium-226 and radium-228 and 15 pCi/L for gross alpha activity excluding radon and uranium. Concentration limits for radium-226 in soils for land cleanup actions are set at 5 pCi/g averaged over the upper 15 cm (6 in.) and 15 pCi/g averaged over any 15-cm- (6-in.) thick layer more than 15 cm (6 in.) from the surface. The level of gamma radiation in any occupiable building is not to exceed 20 microroentgens/hr above background.	Requirements of this act are relevant and appropriate because radium-226 is present in 200 Area soils. The standard is not applicable because the operable unit is not a milling site for uranium or thorium.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
DOE Order 5400.5, Radiation Protection of the Public and the Environment, and 10 CFR 834 (Proposed)	To be considered	This DOE Order sets radiation standards for protection of the public in the vicinity of DOE facilities. The order set limits for the annual effective dose equivalent of 100 mrem, but allows temporary limits of 500 mrem if avoidance of higher exposures is impractical. The standard sets annual dose limits for any organ at 5 mrem. An annual dose equivalent from drinking water supplies operated by DOE is set at 4 mrem and states that liquid effluent from DOE activities will not cause public drinking water systems to exceed EPA MCLs. Where residual radioactive materials remain, the proposed rule states that various disposal modes should address impacts beyond the 1,000-year time period identified in the existing DOE Order.	The DOE Order and proposed rulemaking are to be considered during cleanup actions at the 200 Areas. The DOE published proposed rule, Radiation Protection of the Public and the Environment (10 CFR 834), in the March 23, 1993 Federal Register (58 FR 16268), promulgates the standards presently found in DOE Order 5400.5. The proposed rule identifies DCGs not as "acceptable" discharge limits, but to be used as reference values for estimating potential dose and determining compliance with the requirements of the proposed rule.
Toxic Substances Control Act (TSCA), 15 USC 2601 et seq.			
Regulation of PCBs, 40 CFR 761	ARAR	These requirements identify standards applicable to the handling and disposal of PCBs.	TSCA requirements are applicable to remedial actions where PCBs are present at a 200 Areas site. However, handling, storage, and disposal requirements are only applicable if PCBs are detected above 50 ppm.
Radiation Site Cleanup Standards, 40 CFR 196 (Advanced Notice of Proposed Rulemaking)	To be considered	On October 21, 1993, the EPA published an Advanced Notice of Proposed Rulemaking for development of Radiation Site Cleanup Standards (proposed as 40 CFR 196, 58 FR 54474). It sets standards for the remediation of soil, groundwater, surface water, and structures at federal facilities. The working draft of the proposed regulations (May 1994) presents a cleanup standard of 15 mrem/yr annual effective dose in excess of natural background radiation levels.	This proposed rule is to be considered during 200 Areas cleanup activities. EPA OSWER Directive No. 9200.4-18 has indicated that the 15 mrem/yr annual effective dose originating from this proposal is to be used for protection of human health and the environment.
LOCATION SPECIFIC			
National Historic Preservation Act of 1966, 16 USC 470	ARAR	Requires that historically significant properties be protected. The act requires that agencies undertaking projects must evaluate impacts to properties listed on or eligible for inclusion on the National Register of Historic Places. The National Register of Historic Places is a list of sites, buildings, or other resources identified as significant to United States history. An eligibility determination provides a site the same level of protection as a site listed on the National Register of Historic Places. The regulations implementing the act require that the lead agency for a project identify, evaluate, and determine the effects of the project on any cultural resource sites that may be within the area impacted by the project. The implementing regulations require that negative impacts be resolved.	This law is applicable to actions at 200 Areas because various buildings/ structures are eligible for the National Register.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Archeological and Historic Preservation Act, 16 USC 469a	ARAR	Requires that actions conducted at the site must not cause the loss of any archeological and historic data. This act mandates preservation of the data and does not require protection of the actual facility. Where a site is determined to be eligible for the National Register and mitigation is unavailable, artifacts and data will be recovered and preserved prior to commencement of the action.	Archeological and historic sites have been identified within the 200 Areas, and therefore these requirements are applicable to actions that might disturb these sites.
Endangered Species Act of 1973, 16 USC 1531, et seq.	ARAR	This act prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect this resource.	The Endangered Species Act of 1973 would be considered relevant and appropriate if threatened or endangered species are identified in waste site areas. Their presence could dictate the approach to remedial actions that may be necessary.
ACTION SPECIFIC			
Resource Conservation and Recovery Act, as amended, 42 USC 6901			
Guidelines for Land Disposal of Solid Waste 40 CFR 241	ARAR	Establishes requirements for handling and disposal of solid waste. Included in these requirements are design and closure/postclosure standards for cover systems.	These requirements are applicable because solid waste disposal units may be associated with 200 Area waste sites.
Generator Standards, 40 CFR 262	ARAR	Establishes requirements for facilities that generate hazardous waste. Requirements specify packaging, training, emergency preparedness planning, and recordkeeping procedures.	These requirements are applicable because hazardous waste may be generated during 200 Area actions.
Standards Applicable to Transporters of Hazardous Waste, 40 CFR 263	ARAR	Establishes standards applicable to transporters of hazardous wastes. Transporters must maintain records concerning generator's delivery to treatment, storage, and disposal facilities; proper labeling of transported waste; and compliance with manifest system.	These requirements are applicable because hazardous waste may be generated during 200 Areas remedial actions and require transport to a treatment, storage, or disposal facility.
Standards for Owners and Operators of TSD Units, 40 CFR 264 and 265	ARAR	Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities. Standards include general facility requirements for employee training, emergency preparedness and contingency planning and closure and postclosure requirements for applicable units. Unit-specific requirements are contained in various subparts of this regulation and include standards for containers, tanks, waste piles, surface impoundments, landfills, containment buildings, drip pads, and miscellaneous units. Standards for groundwater monitoring, corrective action at sites with releases to groundwater, and corrective action management units/temporary units are also found in this part as are standards for air emissions from process vents and equipment leaks.	These requirements are applicable to the 200 Areas at TSD units. For non-TSD units, the substantive regulatory requirements for owners and operators of hazardous waste storage, treatment, or disposal facilities are relevant and appropriate if hazardous wastes are stored longer than 90 days or treated, or disposed on site in TSD-like units.
Land Disposal Restrictions, 40 CFR 268	ARAR	These requirements prohibit the placement of restricted RCRA hazardous wastes in land-based units such as landfills, surface impoundments, and waste piles until treated to standards considered protective for disposal. Specific treatment standards are included in the requirements.	These requirements are applicable if restricted waste is generated during characterization or remediation.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Clean Air Act of 1977, as amended 42 USC 7401, et seq.			
National Ambient Air Quality Standards, 40 CFR 50	ARAR	Requirements of these regulations are applicable to airborne releases of criteria pollutants specified under the statute. Specific release limits for particulates are set at 50 µg/m^3 annually or 150 µg/m^3 per 24-hour period.	Applicable to airborne releases of radionuclides and criteria pollutants that may be generated during 200 Area characterization or remedial actions.
Ambient Air Quality Monitoring, 40 CFR 58	ARAR	This regulation presents the criteria and requirements for ambient air quality monitoring and reporting for local air pollution control agencies and operators of new sources of air pollutants.	Not applicable to 200 Areas activities because remedial actions do not meet the regulatory definition of a new source. However, these requirements may be considered relevant and appropriate to remedial actions that have the potential to emit air contaminants.
Standards of Performance for New Stationary Sources, 40 CFR 60	ARAR	These requirements provide standards for new stationary sources or modifications of existing sources.	Remedial actions may include stationary sources for which the substantive requirements would be applicable.
National Emission Standard for Hazardous Air Pollutants (NESHAP), 40 CFR 61	ARAR	40 CFR 61 provides general requirements and listings for regulated emissions at a regulated facility	These requirements are applicable to remedial actions that release air emissions into unrestricted areas.
Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities, 40 CFR 61	ARAR	Subpart H sets emissions limits to ambient air from the entire facility not to exceed an amount that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. The definition of facility for the Hanford Site includes all buildings, structures, and operations collectively as one contiguous site. Radionuclide emission are to be monitored and effective dose equivalent values to members of the public calculated.	These requirements are applicable to the site and remedial alternatives because the potential to release air emissions to unrestricted areas exists.
National Emission Standards for Asbestos, Standard for Demolition and Renovation, 40 CFR 61.145 – 150	ARAR	This section specifies that facilities are to be inspected for the presence of asbestos prior to demolition. The standard defines regulated asbestos-containing materials and establishes removal requirements based on quantity present and handling requirements. These requirements also specify handling and disposal requirements for regulated sources having the potential to emit asbestos. Specifically, no visible emissions are allowed during handling, packaging, and transport of asbestos-containing materials.	These requirements may be applicable if remedial actions require demolition of buildings or structures containing regulated asbestos-containing materials
National Emission Standards for Asbestos, Standards for Active Waste Disposal Sites, 40 CFR 61.154	ARAR	This regulation establishes operating requirements for landfills that handle asbestos-containing wastes. The standard specifies that management practices for asbestos-containing materials are not to allow any visible emissions of asbestos-containing material.	This standard is not applicable since the operable unit is not considered an active landfill. However, the standard is relevant and appropriate because asbestos-containing materials may be present in the inactive burial grounds within the operable unit.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Radioactive Waste Management, DOE Order 5820.2A	To be considered	These guidelines set performance objectives to limit the annual effective dose equivalent beyond the facility boundary to 25 mrem. Disposal methods selected must be sufficient to limit the annual effective dose equivalent to 100 mrem for continuous exposure or 500 mrem for acute exposures when active institutional controls are removed.	Policies and guidelines established for the management of radioactive waste and contaminated facilities should be considered during selection of remedial alternatives. These standards are TBC under CERCLA because they are not federally promulgated regulations. However, compliance with DOE orders is required at the Hanford Site.
Radiation Protection for Occupational Workers, DOE Order 5480.11	To be considered	DOE Order 5480.11 implements radiation protection standards and program requirements for worker protection at DOE and DOE-contractor operations. These standards were developed to be consistent with EPA standards and are based on recommendations by organizations recognized as authorities in the area of radiation protection. Limiting values for an annual effective dose equivalent to a worker from both internal and external sources received in any year is 5 rem. The limiting value to specific organs and tissues is 15 rem to the lens of the eye or 50 rem to any other organ or extremity of the body. Additional limiting values are established for the unborn (0.5 rem/yr) and children and minors (0.1 rem/yr). Radiation protection standards for the public entering controlled areas are set at 0.1 rem/yr from the committed effective dose equivalent from any external radiation. In addition, exposure shall not cause a dose equivalent to any tissue to exceed 5 rem/yr.	These standards are TBC under CERCLA because they are not federally promulgated regulations. However, compliance with DOE orders is required at the Hanford Site. DOE policy is to maintain radiation exposure ALARA and as low as possible where limiting values have been established.
Atomic Energy Act of 1954, as amended, 42 USC 2011, et seq.			
Licensing Requirements for the Land Disposal of Radioactive Waste, 10 CFR 61	ARAR	Requires that disposal systems be designed to limit the annual dose equivalent beyond the facility boundary below 25 mrem to the whole body, 75 mrem to the thyroid, or 25 mrem to any other organ are relevant and appropriate to remedial actions that include land disposal or release radioactive effluent. Inadvertent intruder requirements for land disposal units are also contained in this regulation	The regulation is not applicable because it applies to land disposal of radioactive wastes containing byproduct, source, and special nuclear material received from other persons. However, it is relevant and appropriate if radioactive waste will be left in place following remediation. Requirements to protect inadvertent intruders may also be relevant and appropriate to actions implemented at the site.
Packaging and Transportation of Radioactive Material, 10 CFR 71	ARAR	These requirements apply to the packaging, preparation for shipment, and transportation of licensed radioactive material.	The regulations are only applicable for NRC-licensed plants and facilities where material is transported outside the confines of the plant. The Hanford Site is not an NRC-licensed plant; however, potentially radioactive waste will be generated by remedial actions in the operable unit. Subparts of this regulation are relevant and appropriate for packaging, testing, and preparation of packages containing radioactive material.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes, 40 CFR 191	ARAR	These requirements state that radionuclide release to the environment for a period of 10,000 years after disposal shall have a likelihood of less than one chance in ten of exceeding the level specified in Appendix A, Table 1 of the regulation, or a likelihood of less than one in 1,000 chance of exceeding 10 times the limit specified in Appendix A, Table 1.	Containment requirements established by this standard are potentially applicable relevant and appropriate because transuranic wastes may be generated during 200 Areas remediation and will require disposal in accordance with this regulation.
Department of Energy Occupational Radiation Protection, 10 CFR 835	ARAR	These requirements set occupational dose limits for adults. Total effective dose equivalent is equal to 5 rem/yr	Standards for occupational dose limits are applicable to 200 Areas remedial actions.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings. 40 CFR 192	ARAR	Standards for cleanup are set under this program including groundwater protection requirements for radium-226, radium-228, and gross alpha particle activity, which are set at levels established under state and federal water quality criteria programs.	Standards for cleanup set under this program are relevant and appropriate to remedial actions conducted at the site. The standard is not applicable because the operable unit is not a uranium or thorium milling site.
Hazardous Materials Transportation Act, 49 USC 1801, et seq.			
Hazardous Materials Regulation, 49 CFR 171	ARAR	These requirements state that no person may offer to accept hazardous material for transportation in commerce unless the material is properly classed, described, packaged, marked, labeled, and in condition for shipment.	These requirements are applicable to hazardous material generated during remediation that would be sent offsite for disposal.
Hazardous Materials Tables, Hazardous Materials Communications Requirements, and Emergency Response Information Requirements, 49 CFR 172	ARAR	Tables are used to identify requirements for labeling, packaging, and transportation based on categories of waste types. Small quantities of radioactive wastes are not subject to the requirements of the standard if activity levels are below limits established in paragraph 173.421, 173.422, or 173.424. Specific performance requirements are established for packages used for shipping and transport of hazardous materials.	These requirements are applicable if hazardous waste is generated during remediation and is transported offsite. In the event of a discharge of hazardous waste during transportation from the treatment facility to the disposal facility, this section is applicable.
Guidance on Remedial Actions for Superfund Sites With PCB Contamination, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response	To be considered	This document provides guidance for evaluating and selecting a remedy for sites contaminated with PCBs. The guidance presents a range of preliminary remediation goals for the cleanup of PCB-contaminated sites that are protective of human health and intended to meet the goals of the NCP and TSCA. EPA guidance notes that in selecting a response action under CERCLA, cleanup levels and disposal methods should be selected based on the form and concentration found at the site and not according to the TSCA anti-dilution provisions.	This guidance is to be considered during 200 Areas remedial actions. Should PCB wastes be excavated during remediation, specific TSCA treatment and disposal requirements are considered applicable.

Table 4-1. Identification of Potential Federal ARARs and TBCs for the 200 Areas Remedial Action Sites. (9 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, or To Be Considered	Requirement	Rationale for Use
Executive Order 12856, Federal Compliance with Right- to-Know Laws and Pollution Prevention Requirements	To be considered	Requires that federal agencies will comply with Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA) and the Pollution Prevention Act of 1990 (PPA) to the extent that private entities would. The EO incorporates by reference all implementing regulations of EPCRA and the PPA. EPCRA requires tracking and reporting information on the storage, use, and release of extremely hazardous substances, hazardous substances, listed chemicals, and toxic chemicals to inform the public about the presence of such hazards in their community and to provide emergency planners and emergency response organizations with information needed to provide appropriate response to potential emergencies at the facilities. The PPA requires entities to implement practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources; or protection of natural resources by conservation.	Applicable to federal agencies that either own or operate a "facility" as that term is defined in section 329(4) of EPCRA if such facility meets the threshold requirements set forth in EPCRA. The Hanford Site meets the definition and threshold requirements.
DOE 1998, Draft Hanford Remedial Action Environmental Impact Statement, DOE 1998	To be considered	The draft Hanford Remedial Action EIS will define land-use decisions for the Hanford Site including 200 Areas Burial Ground sites.	As a draft, this EIS is to be considered during remedial action decision making for the 200 Areas Burial Grounds.
DOE 1996b, "Guidance for a Composite Analysis of the Impact of Interacting Source Terms on the Radiological Protection of the Public from Department of Energy Low-Level Waste Disposal Facilities"	To be considered	The Composite Analysis provides an estimate of the cumulative radiological impacts from active and planned low-level radioactive waste disposal actions and other potentially interacting radioactive waste disposal sources that will remain following Hanford Site closure.	This TBC guidance from DOE is pertinent to 200 Area waste sites that will leave radiological contaminants in place following remediation.
Endangered Species Act of 1973, 16 USC 1531, et seq.	ARAR	This act prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect this resource.	The Endangered Species Act of 1973 would be considered relevant and appropriate if threatened or endangered species are identified in waste site areas. Their presence could dictate the approach to remedial actions that may be necessary.

ACL = alternate concentration level
ALARA = as low as reasonably achievable
CAMU = corrective action management unit
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
DCG = derived concentration guide
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
HCRL = Hanford Cultural Resources Laboratory
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
NESHAP = National Emission Standards for Hazardous Air Pollutants
NCP = National Oil and Hazardous Substance Contingency Plan
NEPA = National Environmental Policy Act
NPDES = National Pollutant Discharge Elimination System
NRC = U.S. Nuclear Regulatory Commission
PCB = polychlorinated biphenyls
RCRA = *Resource Conservation and Recovery Act*
SDWA = Safe Drinking Water Act
TBC = to be considered
TSCA = Toxic Substance Control Act

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
CHEMICAL SPECIFIC			
Hazardous Waste Clean Up/Model Toxics Control Act, Ch. 70.105D RCW			
Model Toxics Control Act, WAC 173-340	ARAR	Identifies the methods used to develop cleanup standards and their use in selection of a cleanup action. Cleanup levels are based on protection of human health and the environment, the location of the site, and other regulations that apply to the site. The standard specifies cleanup goals that implement the strictest federal or state cleanup criteria. In addition to meeting requirements of other regulations, MTCA uses three basic methods for establishing cleanup levels; these methods may be used to identify cleanup standards for groundwater, surface water, soils, and protection of air quality. Cleanup levels for soils may be calculated using Method A - routine, Method B – standard method, and Method C – conditional standards. MCLs, MCLGs, and secondary drinking water standards are identified in the regulation as potential groundwater cleanup criteria.	Requirements of MTCA are relevant and appropriate to 200 Area remedial actions.
Dangerous Waste Regulations, Ch. 70.105 RCW			
Dangerous Waste Regulations, WAC 173-303			
Designation of Waste, WAC 173-303-070 through 110	ARAR	Establishes the methods and procedures to determine if solid waste requires management as dangerous waste.	The requirements of this section are applicable because dangerous waste might be generated during characterization and remedial actions.
Releases from regulated units, WAC 173-303-645	ARAR	Establishes action levels for releases to groundwater from dangerous waste management units.	The standard is applicable since TSD units are present in the 200 Areas.
Solid Waste Management, Recovery and Recycling Act, Ch. 70.95 RCW			
Minimum Functional Standards for Solid Waste Handling, WAC 173-304-460	ARAR	Sets groundwater MCLs at the same levels as the drinking water standards under 40 CFR 141.	The standard is applicable since waste management facilities are present in the 200 Areas.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Water Pollution Control/Water Resource Act of 1971, Ch. 90.48 RCW/Ch. 90.54 RCW			
Surface Water Quality Standards, WAC 173-201A	ARAR	These standards set water quality standards at levels protective of aquatic life.	Groundwater below the 200 Areas discharges to the Columbia River; therefore, surface water quality criteria established under this chapter must be taken under consideration when developing cleanup standards for soil and groundwater associated with 200 Areas remedial actions.
Department of Health Standards for Public Water Supplies, WAC 246-290	ARAR	The rule established under WAC 246-290 defines the regulatory requirements necessary to protect consumers using public drinking water supplies. The rules are intended to conform with the federal SDWA, as amended. WAC 246-290-310 establishes MCLs that define the water quality requirements for public water supplies. WAC 246-290-310 establishes both primary and secondary MCLs and identifies that enforcement of the primary standards is the Department of Health's first priority.	The requirements of WAC 246-290-310 are relevant and appropriate to 200 Area remedial actions because groundwater is classified as a potential future source of drinking water.
State Radiation Protection Requirements, Ch. 70.98 RCW			
Radiation Protection Standards, WAC 246-221	ARAR	Washington State Radiation Protection Requirements are implemented under specific sections of WAC 246. Chapter 246-221-290 establishes annual average concentration limits for radioactive releases in gaseous and liquid effluent released to unrestricted areas. Occupational dose to adults and minors are set in these requirements. Dose limits that individual members of the public may receive in unrestricted areas from external sources are also set. The standard identifies the methods required to demonstrate compliance and provides derived air concentration and annual limit on uptake values that may be used to determine an individual's occupational dose. The standard specifies requirements for monitoring personnel exposure for both external and internal exposure.	This regulation is not applicable because it does not apply to Federal agencies under the AEA. However, it is considered relevant and appropriate because it establishes standards for acceptable levels of exposure to radiation..

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Washington Clean Air Act, Ch. 70.94 RCW and Ch. 43.21A RCW			
Radiation Protection - Air Emissions, WAC 246-247	ARAR	This regulation promulgates air-emission limits for airborne radionuclide emissions as defined in WAC 173-480 and 40 CFR 61 Subparts H and I. The ambient air standards under WAC 173-480 require that the most stringent standard be enforced. Ambient air standards under 40 CFR 61 Subparts H and I are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. The ambient standard in WAC 173-480 specifies that emission of radionuclides to the air must not cause a dose equivalent of 25 mrem/yr to the whole body or 75 mrem/yr to any critical organ. These standard specify emission monitoring requirements and the application of best available radionuclide technology requirements.	This regulation is considered applicable because it sets emission limits and use of BART for airborne radionuclides.
Radiation Protection at Uranium and Thorium Milling Operations, WAC 246-252	ARAR	Radium-226 concentrations are required to be less than 5 pCi/g averaged over the upper 15 cm and not more than 15 pCi/g averaged over any 15-cm interval deeper than 15 cm from the surface. Groundwater protection standards established for gross alpha excluding radon and uranium are set at 15 pCi/L, and for combined radium-226 and radium-228 not to exceed 5 pCi/L.	This is not applicable to 200 Areas remedial actions because sites were not uranium or thorium milling operations; however, the regulation is relevant and appropriate because it contains specific soil cleanup limits for radium-226 and radium-228 and groundwater protection limits.
LOCATION SPECIFIC			
Department of Game Procedures, WAC 232-012	ARAR	This standard defines the requirements that the Department of Game must take to protect endangered or threatened wildlife.	These requirements may be applicable if endangered or threatened wildlife are identified in the 200 Areas during wildlife surveys. The requirements of this chapter will be reevaluated should protected wildlife species be identified within the 200 Areas.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
National Area Preserves. RCW 79.70			
Washington Natural Heritage Program	To be considered	The Washington State Natural Heritage Program is authorized under RCW 79.70, Natural Area Preserves, and serves as an advisory council to the Washington State Department of Natural Resources, Fish and Wildlife, the Parks and Recreation Commission, and other state agencies managing state-owned land or natural resources. The list of state endangered, threatened, and sensitive plants developed by the program, along with program-recommended levels of protection, are to be used to assist resource managers in determining which species of concern occur in their areas and recommend protection. The designations provided to plants by the Washington State Natural Heritage program are advisory and do not specify a regulatory level of protection.	The requirements of the Natural Heritage Program are TBC guidance for remedial actions at the 200 Areas. No threatened or endangered plant species have been currently identified in the 200 Areas.
ACTION SPECIFIC			
Hazardous Waste Cleanup-Model Toxics Control Act, Ch. 70.105D RCW			
Model Toxics Control Act Cleanup Regulations, WAC 173-340	ARAR	Establishes a process for cleanup of contaminated sites in the state. Specifies that all cleanup actions be protective of human health, comply with all applicable state and federal regulations, and provide for compliance monitoring.	Requirements of MTCA are relevant and appropriate to 200 Areas remedial actions. State requirements that are not authorized through a federal program, such as MTCA, are not applicable to federal facilities.
Hazardous Waste Management Act, 70.105 RCW			
Dangerous Waste Regulations, WAC 173-303	ARAR	Establishes the design, operation, and monitoring requirements for management of dangerous waste.	Applicable to 200 Areas TSD units and to dangerous wastes generated during remedial activities. All sections of this chapter may be applicable to dangerous waste management activities during 200 Areas remediation. Key sections are highlighted below.
Land Disposal Restrictions, WAC 173-303-140	ARAR	Identifies dangerous wastes that are restricted from land disposal and describes requirements for state-only restricted wastes, and define the circumstances under which a prohibited waste may be disposed.	Applicable to the disposal of dangerous waste generated during 200 Areas characterization and remedial actions.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Spills and Discharges into the Environment, WAC 173-303-145	ARAR	Sets forth the requirements that apply when any dangerous waste or hazardous substance is intentionally or accidentally spilled or discharged into the environment such that human health and the environment are threatened, regardless of the quantity of dangerous waste or hazardous substance.	Applicable should dangerous waste or hazardous substances be spilled or discharged into the environment.
Requirements for Generators of Dangerous Waste, WAC 173-303-170 through 230	ARAR	Requirements defined under this section include a 90-day waste accumulation period, specific levels of training, emergency preparedness, and record keeping.	Applicable to actions performed at the site if dangerous waste is generated.
General Requirements for Dangerous Waste Management Facilities, WAC 173-303-280 through 395	ARAR	General requirements include siting standards and procedures for permitting, training, emergency preparedness, security, inspections, contingency planning, waste analysis, and management of containers.	Applicable to remedial actions that include treatment, storage, or disposal of designated dangerous waste.
Treatment, Storage, and Disposal Facility Requirements, WAC 173-303-600 through 695	ARAR	Specifies closure and postclosure standards (which require compliance with MTCA cleanup levels), groundwater monitoring requirements, corrective action management unit/temporary unit requirements, air emission standards for process vents and equipment leaks, and specific unit requirements for: containers; tanks, surface impoundments, land treatment units, waste piles, landfills, incinerators, drip pads, miscellaneous units, and containment buildings.	Applicable to the 200 Areas because permitted TSD units are present and relevant and appropriate because remediation wastes from sites may be managed in units meeting TSD definition.
Solid Waste Management, Recovery, and Recycling Act, Ch. 70.95 RCW			
Minimum Functional Standards for Solid Waste Handling, WAC 173-304	ARAR	These standards establish requirements to be met for the management of solid waste. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, and ashes. Requirements for containerized storage, collection, transportation, treatment, and disposal of solid waste are included.	These regulations are applicable to onsite management and disposal of solid waste that may be generated during characterization or remedial activities.
Water Well Construction, Ch. 18.104 RCW			
Minimum Standards for Construction and Maintenance of Water Wells, WAC 173-160	ARAR	These requirements establish minimum standards for design, construction, capping, and sealing of all wells; sets additional requirements, including disinfection of equipment, decommissioning of wells, and quality of drilling water.	These requirements are applicable to actions that include construction of wells used for groundwater extraction, monitoring, or injection of treated groundwater or wastes.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Rules and Regulations Governing the Licensing of Well Contractors and Operators, WAC 173-162	ARAR	This regulation establishes procedures for the examination, licensing and continuing education, and regulation of well contractors and operators.	This regulation is applicable to remedial actions where groundwater wells will be installed.
Water Pollution Control/Water Resources Act, Ch. 90.48 RCW/Ch. 90.54 RCW			
Protection of Upper Aquifer Zones, WAC 173-154	ARAR	This regulation directs Ecology to provide for protection of upper aquifers and upper aquifer zones to avoid depletions, excessive water level declines, or reductions in water quality.	This regulation is not applicable to remedial actions because it establishes the policy and program for Ecology. However, the regulation is considered relevant and appropriate since protection of the aquifer from adverse impacts caused by waste management units is a primary goal.
State Waste Discharge Program, WAC 173-216	ARAR	The chapter implements a permit system applicable to industrial and commercial operations that discharge to the groundwater, surface waters, or municipal sewerage systems. Specific discharges prohibited under the program are identified. The intent of the law is to maintain the highest possible standards, and the law requires the use of all known available and reasonable methods to prevent and control the discharge of wastes into the waters of the state.	Requirements of this program are applicable to remedial actions that include discharges to the ground.
Washington Clean Air Act, Ch. 70.94 RCW and Ch. 43.21A RCW			
General Regulations for Air Pollution, WAC 173-400	ARAR	The regulation requires that all sources of air contaminants meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. This section requires that all emission units use reasonably available control technology, which may be determined for some source categories to be more stringent than the emission limitations listed in this chapter. The regulation requires that source testing and monitoring be performed. A new source would include any process or source that may increase emissions or ambient air concentration of any contaminant for which federal or state ambient or emission standards have been established.	Requirements of this standard are applicable to remedial actions performed at the site that could result in the emission of hazardous air pollutants. Substantive standards established for the control and prevention of air pollution under this regulation are applicable to remedial actions that may be proposed at a site.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Controls for New Sources of Air Pollution, WAC 173-460	ARAR	This standard requires that new sources of air emissions provide emission estimates for toxic air contaminants listed in the regulation. The standard requires that emissions be quantified and used in risk modeling to evaluate ambient impacts and establish acceptable source impact levels. The standard establishes three major requirements for new sources of air pollutants: use of best available control technology, quantification of toxic emissions, and demonstration that human health is protected.	The standard is relevant and appropriate to remedial actions because nonradioactive operable unit contaminants of concern are identified in the regulation as toxic air contaminants.
Ambient Air Quality Standards for Particulate Matter, WAC 173-470	ARAR	These requirements set maximum acceptable levels for particulate matter in the ambient air at 150 $\mu g/m^3$ over a 24-hour period, or 60 $\mu g/m^3$ annual geometric mean. It also sets the 24-hour ambient air concentration standard for particles less than 10 μm in diameter (PM_{10}), which are set at 105 $\mu g/m^3$ and 50 $\mu g/m^3$ geometric mean. The section defines standards for particle fallout not to exceed 10 g/m^2 per month in an industrial area or 5 g/m^2 per month in residential or commercial areas. Alternate levels for areas where natural dust levels exceed 3.5 g/m^2 per month are set at 6.5 g/m^2 per month, plus background levels for industrial areas, and 1.5 g/m^2 per month plus background in residential and commercial areas.	These state-authorized requirements are applicable to remedial actions that may emit particulate matter to the air.
Ambient Air Quality Standards and Emission Limits for Radionuclides, WAC 173-480	ARAR	These requirements establish that the most stringent federal or state ambient air quality standard for radionuclides be enforced. The WAC 173-480 standard defines the maximum allowable level for radionuclides in the ambient air, which shall not cause a maximum accumulated dose equivalent of 25 mrem/yr to the whole body or 75 mrem/yr to any critical organ. However, ambient air standards under 40 CFR 61 Subparts H and I are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. Emission standards for new and modified emission units shall utilize best available radionuclide control technology.	Requirements of this standard are relevant and appropriate to remedial actions performed at the site that may emit radionuclides to the air.

Table 4-2. Identification of Potential State ARARs and TBCs for the 200 Areas Remedial Action Sites. (8 Sheets)

ARAR Citation	Applicable, Relevant and Appropriate, To Be Considered	Requirement	Rationale for Use
Emission Standards and Controls for Sources Emitting Volatile Organic Compounds (VOC), WAC 173-490	ARAR	This chapter establishes technically feasible and attainable standards for sources emitting volatile organic compounds.	This regulation is probably not applicable to remedial actions conducted at the 200 Areas because the source of potential volatile organic compound emissions generated by remedial actions most likely do not meet the definition of emission sources specified under WAC 173-490-03. However, this regulation may be considered relevant and appropriate if remedial actions have the potential to emit volatile organic compounds into the air.
State Radiation Protection Requirements, Ch. 70.98 RCW			
Radioactive Waste-Licensing Land Disposal, WAC 246-250	ARAR	WAC 246-250 establishes the procedures, criteria, and conditions for licensing of low-level radioactive waste land disposal facilities. This section presents specific levels of radiation protection and technical requirements for land disposal of radioactive waste.	These requirements are considered relevant and appropriate if remedial alternatives allow radioactive waste to remain on site.
State Environmental Policy Act, Ch. 43.21C RCW			
SEPA Rules, WAC 197-11	ARAR	These requirements establish compliance with the State Environmental Policy Act.	These requirements are applicable to remedial actions at the 200 Areas.

CERCLA= Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
Ecology = Washington Department of Ecology
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
MTCA = Model Toxics Control Act
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
SDWA = Safe Drinking Water Act
TBC = to be considered
TSD = treatment, storage, and disposal
VOC = Volatile Organic Compounds
WAC = Washington Administrative Code.

5.0 CONCEPTUAL EXPOSURE MODEL AND RISK ASSESSMENT

This section introduces a conceptual exposure model for establishing remedial action objectives (RAOs), preliminary remediation goals (PRGs), and an approach to risk assessment that are applicable to environmental remediation of the 200 Areas.

A conceptual exposure model provides critical information to the characterization and remedial alternative selection phases of both the CERCLA and RCRA remediation processes (see Section 2.0). Prior to the characterization phase, a preliminary conceptual exposure model summarizes what is known about a site and serves as a basis for defining characterization needs. After the characterization phase, a refined conceptual exposure model identifies potential exposure pathways that may need to be addressed through remedial action and provides information critical to remedial alternative selection. A risk assessment, by identifying risks to human health and the environment associated with the potential exposures identified in the model, helps determine if remedial action is warranted.

An overall conceptual exposure model was developed for the Implementation Plan which addresses all the environmental restoration sites in the 200 Areas. During group-specific DQO and characterization planning, this preliminary model will serve as a starting point for the development of a conceptual exposure model for each waste group. After waste group characterization is completed, group-specific conceptual exposure models will be verified or revised to help focus future waste site-specific characterization efforts, help determine risk assessment requirements, and aid in the selection of remedial alternatives.

This section begins with a discussion of anticipated land use for the 200 Areas and a presentation of the preliminary conceptual exposure model for the entire 200 Areas. The conceptual exposure model integrates the generalized conceptual contaminant distribution concepts presented in Section 3.3 (Figures 3-2 and 3-3) with potential exposure pathways and routes to provide a basis for evaluating current or potential future risks. These risks are addressed by RAOs intended to protect human health and the environment, and by PRGs, which are typically numerical representations of the RAOs usually based on regulatory standards (e.g., ARARs) or readily available risk-based criteria. The RAOs and PRGs presented in this document are preliminary and general in nature. Group-specific characterization data gathered to verify or revise the group-specific conceptual exposure models will serve to better define the RAOs for a particular waste group. Rather than presenting specific contaminant concentrations, this section presents a range of potentially applicable cleanup standards and points of compliance. Contaminant-specific, numeric PRGs will be developed in future group-specific work plans or FS reports.

This section concludes with an approach for implementing risk assessment during the remediation of the 200 Areas. This approach is general, and it is intended to guide future applications of group-specific risk assessments.

5.1 ANTICIPATED LAND USE

Anticipated future land use helps define a conceptual exposure model and associated exposure scenarios. These may in turn influence characterization needs and remedial action decisions. Future land use for the 200 Areas is not definitive at this time. Alternatives for potential future use of Hanford Site lands were developed through a cooperative effort with the DOE, and Natural Resource Damage Assessment stakeholders (the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe Department of Environmental Restoration and Waste Management, the U.S. Department of Interior, the Washington Department of Fish and Wildlife, the City of Richland, and Benton, Franklin, and Grant counties). These alternatives are included in the *Hanford Remedial Action Environmental Impact*

Statement and Comprehensive Land Use Plan (DOE 1996a) and are the basis for the DOE proposal for land use at this time. A land-use alternative will be identified in a ROD planned for 1998. Figure 5-1 illustrates the DOE-preferred land-use alternative presented in the HRA-EIS.

All of the HRA-EIS alternatives propose industrial (exclusive) use for land located within the 200 Areas land-use boundary line and preservation and conservation uses for land located immediately outside the boundary line. An industrial (exclusive) land use is defined as an area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes. However, there is no provision for an "industrial (exclusive)" land use in the regulations at this time. Only an industrial land use is recognized by the EPA and Ecology. Preservation is defined as an area managed for the preservation of archeological, cultural, ecological, and natural resources; no new consumptive uses (e.g., mining) would be allowed within this area. Conservation is defined as an area reserved for the management and protection of archeological, cultural, ecological, and natural resources; limited and managed mining and grazing could occur as a conditional use (e.g., a permit would be required) within appropriate areas (DOE 1998a). EPA and Ecology believe that there are certain portions of the 200 Areas that may be potentially considered as a rural residential scenario. A rural residential scenario is defined as one in which an individual resident consumes crops raised in a backyard garden, consumes animal products from locally-raised livestock or game animals (including fish), lives in a residence with a basement 3.7 m (12 ft) below grade, and obtains water for drinking and irrigation purposes from an uncontaminated source (the Columbia River). MTCA specifies that a site be zoned as "industrial" under the *Growth Management Act* of the State of Washington to be defined as "industrial," but the *Growth Management Act* does not apply to federal facilities. Therefore, it is assumed that the HRA-EIS will be put in place to establish land use for the Hanford Site in parallel with the 200 Areas Implementation Plan.

Most of the waste sites in the 200 Areas (200 East and West Areas) are located within the proposed industrial (exclusive) land-use boundary line of the HRA-EIS (Plate I) and fall under the industrial (exclusive) land-use designation. However, some sites are located outside the proposed industrial (exclusive) land-use boundary (e.g., 200 North Area and Nonradioactive Dangerous Waste Landfill [NRDWL]) and would fall under the preservation or conservation land-use designation proposed by the HRA-EIS. Sites located outside the land-use boundary may be designated as pre-existing, nonconforming use (defined as any lawfully established use that is neither allowed nor conditionally permitted within a land-use designation, but exists therein, having been established prior to the designation [DOE 1998]). Designation of sites located outside the proposed industrial (exclusive) land-use boundary as having had a pre-existing, nonconforming use may result in remediation to an industrial (exclusive) standard.

Under no current or future land-use scenario is it foreseen that groundwater underlying the 200 Areas or contaminated by 200 Area waste sources will be used for potable water or as an irrigation source under the DOE-preferred land-use alternative.

5.2 CONCEPTUAL EXPOSURE MODEL

From a broad perspective, a conceptual exposure model serves as a graphical summary of the physical characteristics and mechanisms that could potentially affect the generation of contamination, its transport, and its impact on other media (e.g., soil, air, water) and receptors (humans and biota). Specifically, a conceptual exposure model identifies potential exposure pathways (to include the sources of contamination, mechanisms of contaminant release [if applicable], transport media [if applicable], potentially affected media, exposure routes, and potential receptors). A conceptual exposure model summarizes information from a physical contaminant distribution model(s), which generally provides additional details regarding contaminants and contaminant fate and transport mechanisms, to identify exposures that may need to be addressed through remedial action. Initially, a conceptual exposure model represents the *a priori* understanding of a site and serves as a basis for determining assessment needs. The potential exposures identified in a conceptual exposure model serve as inputs for a quantitative or qualitative risk assessment. Characterization data are used to refine or verify the conceptual exposure model before risk assessments are conducted or remedial decisions are made. Figure 5-2 illustrates the conceptual exposure model for the entire 200 Areas.

The nine major process categories defined in Section 3.2.3 and the first column of Figure 5-2 are the primary sources of contamination in the 200 Areas. Contaminants were introduced to the environment by surface and subsurface liquid discharges and surface and subsurface solid waste placements, resulting in nine secondary contaminant sources that are primary waste site types identified in the third column of Figure 5-2. Current or potential future secondary release of contaminants occurs through the mechanisms listed in the fourth column of Figure 5-2. Secondary contaminant release can occur through resuspension of contaminated soils via wind erosion or excavation activities; volatilization of contaminants from wastes and soils into the air or as soil gas; biotic uptake of contaminants via direct contact with soils or ingestion of soils, vegetation, or other animals; migration of contaminated liquids through the soil column via infiltration or percolation; leaching of contaminants from soil to groundwater; external radiation (gamma); and excavation or direct contact with contaminated soils. Media potentially contaminated via primary and secondary releases to the environment are listed in the fifth column of Figure 5-2. Potential receptors (humans and biota) may be exposed to contaminated media through several exposure pathways, including inhalation of volatilized contaminants or suspended dust; ingestion of contaminants in soils, vegetation, or animals or of suspended dust; direct dermal contact with contaminants in soils; and/or direct exposure to external radiation (gamma). Potential human receptors include future workers, future occasional users of a site, and an inadvertent intruder. Potential ecological receptors include terrestrial and aquatic plants and animals.

It is important to note that this report does not attempt to quantify potential human health or environmental risks associated with current or potential future exposure to 200 Areas contaminants. Current and future risks will be evaluated, as necessary, using concepts presented in this report after group-specific characterization data have been collected and reported in the RI report (refer to Section 5.5).

5.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are general descriptions of what remedial action is expected to accomplish (i.e., media-specific or site-specific goals for protecting human health and the environment). Remedial action objectives are generally defined as specifically as possible and usually include the following components:

- Medium of concern
- Types of contaminants
- Possible exposure pathways
- Potential receptors
- Levels of residual contaminants that may remain following remediation (i.e., contaminant levels below cleanup standards or below a range of levels for different exposure routes [i.e., PRG]).

Remedial action objectives provide a basis to evaluate the capability of a specific remedial alternative to achieve compliance with ARARs and/or an intended level-of-risk protection for human health or the environment (refer to Section 4.0). The overall purpose of establishing RAOs is to help ensure that the selected remedial action will be protective of human health and the environment by eliminating or minimizing exposure and/or by removing contaminants or reducing their levels. As discussed previously, the RAOs for this 200 Areas RI/FS Implementation Plan are preliminary, general in nature, and are applicable for the entire 200 Areas. They are intended as a guide for developing group-specific RAOs in future group-specific work plans or FS reports. The preliminary RAOs for the cleanup of the 200 Areas soil waste sites addressed in this plan are:

- Prevent or mitigate risk to human and ecological receptors associated with ingestion of, dermal contact with, inhalation of, and external exposure to contaminants at levels that exceed ARARs or a risk of 10^{-4} to 10^{-6}.
- Prevent or mitigate the migration of contaminants to groundwater such that no further degradation occurs and insure protection of the Columbia River.
- Prevent or mitigate the migration of contaminants to groundwater so that contaminants do not reach levels in groundwater that exceed ARARs or a risk of 10^{-4} to 10^{-6}.
- Prevent plants and animals from creating a migration pathway for the contaminants.
- Prevent or mitigate risk to workers performing remedial action.
- Provide conditions suitable for proposed future land use.
- Prevent destruction of significant cultural resources and sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

5.4 PRELIMINARY REMEDIATION GOALS

Preliminary remediation goals (i.e., cleanup levels) are numeric representations of the RAOs. Using the anticipated future land use, the conceptual exposure model, and the RAOs as a basis, PRGs are identified for applicable contaminants and exposure pathways. Preliminary remediation goals are used to define unacceptable risk posed by specific contaminants, to identify the contaminants that are the most likely risk drivers (i.e., contaminants of concern), to provide target cleanup goals for use during remedial design, and to provide guidance during remediation. They are based on acceptable levels of human health and ecological risk, ARARs, TBC guidance, points of compliance, and remediation timeframes. Contaminant-specific, numeric PRGs are not presented in this document. Instead, potentially applicable standards are outlined. Specific PRGs will be defined for individual contaminants in future group-specific work plans or FS reports. An important aspect of establishing these contaminant-specific PRGs will be the availability of background data regarding soil and groundwater chemistry. Available background data is discussed in Appendix F, Section F7.0, and presented in Tables F-3 and F-4. Potential contaminants of concern are listed in Tables 3-2, 3-3, and 3-4.

The RAOs designed to protect human and ecological receptors from exposure to contaminants will be achieved by meeting PRGs based on the following standards:

- The Tri-Parties-supported radionuclide soil cleanup standard of 15 mrem/yr above background
- The State of Washington's MTCA standards for nonradioactive contaminants.

The RAOs designed to ensure no further degradation of groundwater and protection of the Columbia River will be achieved by meeting PRGs based on the following:

- Maximum contamination levels (MCLs) promulgated under the *Safe Drinking Water Act* or the State of Washington's Drinking Water Standards or, alternate concentration limits (ACLs) established where groundwater restoration is shown to be impracticable.
- The State of Washington's MTCA standards for nonradioactive contaminants.
- Ambient Water Quality Criteria developed under the *Clean Water Act* or the State of Washington's Surface Water Quality Standards.

The above PRGs are initial goals based on standards derived from existing ARARs. In subsequent FSs for each of the waste site groups, PRGs will be reevaluated to reflect ARARs that are current when the FSs are written. Future characterization data may indicate that the initial PRGs are inappropriate. For example, the Tri-Parties-supported 15 mrem/yr standard, which has been applied in other areas of the Hanford Site, may not be practicable or achievable within the confines of the 200 Areas' land-use boundary [DOE's industrial (exclusive) preferred land use option] through the reduction of contaminant concentrations (i.e., waste removal), or the elimination of exposure pathways (e.g., surface barriers). As site- and group-specific data becomes available, these initial PRGs will be evaluated in the FSs and will ultimately be approved by the lead regulatory agency in a ROD.

Setting achievable cleanup levels requires the ability to demonstrate that PRGs have been achieved. Compliance involves specifying the location where the cleanup levels must be attained (i.e., points of compliance) and how long it may take for the cleanup levels to be reached (i.e., restoration time frame). The following are examples of points of compliance and restoration time frames that have been used for other Hanford Site projects. As with RAOs and PRGs, group-specific or site-specific points of compliance and restoration time frames will be refined in future documents, and ultimately set in a ROD.

For soil cleanup levels based on the protection of groundwater and the Columbia River, the point of compliance shall be established in the soils throughout the site (WAC 173-340-740 [6] [b]). For soil cleanup standards based on human exposure via direct contact, the point of compliance will be established at a depth of 4.5 m (15 ft), with the ambient surrounding grade at the time of disposal serving as the excavation depth reference. The point of compliance for engineered structures would extend beyond 4.5 m (15 ft) unless it could be shown that the portions below 4.5 m (15 ft) could remain in place without impacts to human health or the environment. The 4.5-m (15-ft) depth represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities (WAC 173-340-740 [6] [c]). This point of compliance may not be applicable for sites where containment is selected as the remedial alternative (i.e., contaminants remain on site) (WAC 173-340-360[6][d]) or for sites where, based on designated land use, future development will not occur. For sites covered with a surface barrier or for sites designated for preservation or conservation use, the point of compliance could be less than 4.5 m (15 ft) (e.g., the average maximum depth of an animal burrow or a plant root).

For groundwater cleanup levels or cleanup levels established to ensure no further degradation of groundwater (i.e., MCLs and ACLs, respectively), the point of compliance may be in groundwater underlying a site, at the site boundary or the 200 Areas' land-use boundary (a conditional point of compliance), or some other agreed-upon location. For cleanup levels to protect the Columbia River, the point of compliance may be in groundwater at a near-river well, at the groundwater-river substrate interface, or some other agreed-upon location.

Cleanup actions shall provide for a reasonable restoration time frame. The factors to be considered when establishing a reasonable restoration time frame include (WAC 173-340-360 [6]):

- Potential risks posed by the site to human health and the environment
- Practicability of achieving a shorter restoration time frame
- Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor migration of hazardous substances from the site
- Toxicity of hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

Restoration time frames will be determined for each waste group or each site as part of the remedial alternative selection process. Current characteristics of the 200 Areas, including known contaminants, may lend support for the assessment of remedial alternatives with reasonable, yet extended, restoration time frames. Examples include the presence of short-lived radionuclides that will decay to protective levels rather quickly and the presence of contaminants that naturally attenuate in site soils or underlying groundwater. Consistent with EPA guidance (EPA 1997b), monitored natural attenuation, including radioactive decay, is an option that may be evaluated with other applicable remedies for achieving the 200 Areas' RAOs (see discussion of remedial technologies in Appendix D). Remedial alternatives would be required to meet RAOs at the completion of the restoration time frame. Remediation time frames will first be discussed in feasibility studies for waste site groups. Specific schedules for remediation will be defined in RDR/RAWPs done in conjunction with the Hanford Site ER program long range plan for specific groups of waste sites.

The remedial action alternatives presented in Appendix D are general and cover a range of technologies to reflect the potential contamination conditions present in the 200 Areas. Appendix D is intended to satisfy the requirements of a screening phase FS (i.e., Phase I and II FS) by providing the necessary basis to prepare group-specific detailed FSs. Site-specific refinements of the alternatives presented in Appendix D will be made in final group-specific FSs. By completing a screening-level FS in Appendix D and identifying viable alternatives now, a more streamlined RI/FS can be performed. Characterization needs can be more focused if a range of expected remedial alternatives are identified early, and treatability testing needs can also be evaluated and implemented early in the process. The final group-specific FS can then be focused on the detailed analysis of a few viable alternatives.

5.5 RISK ASSESSMENT APPLICATION

The application of risk assessment in the characterization and remediation of the 200 Areas will follow a graded approach. As more data are gathered and the level of understanding increases with regard to the nature and extent of contamination and the details of the conceptual exposure model, and as the objectives of risk assessment change with the evolution of the characterization/remediation process, the approach to risk assessment will change. Depending on objectives determined by the group-specific project managers, risk assessments may range from relatively simple screening evaluations (to decide to take action at an individual site or not), to more rigorous assessments (to determine if a waste site can be released), to even more comprehensive cumulative assessments (to determine if a portion of the 200 Areas NPL site can be released). The risk assessment and modeling requirements will be appropriately adjusted to address these variable technical and regulatory requirements. Remediation time frames will first be discussed in feasibility studies for waste site groups. Specific schedules for remediation will be defined in Remedial Design Report/Remedial Action Work Plans done in conjunction with the Hanford Site ER Program long range plan for specific groups of waste sites.

The remedial action alternatives presented in Appendix D are general and cover a range of technologies to reflect the potential contamination conditions present in the 200 Area. Appendix D is intended to satisfy the requirements of screening phase FS (i.e., Phase I and II FS) by providing the necessary basis to prepare group-specific detailed FSs. Site-specific refinements of the alternatives presented in Appendix D will be made in final group-specific FSs. By completing a screening-level FS in Appendix D and identifying viable alternatives now, a more streamlined RI/FS can be performed. Characterization needs can be more focused if a range of expected remedial alternatives are identified early, and treatability testing needs can be evaluated and implemented early in the process. The final group-specific FS can then be focused on the detailed analysis of a few viable alternatives.

Using available information (e.g., WIDS, AAMS report, Hanford Environmental Information System [HEIS]), initial screening evaluations to determine the need for action (i.e., characterization and/or remediation) and site remediation priorities have already been performed. For example, the 200 Areas' AAMS reports screened waste sites as low- or high-priority based on the CERCLA Hazard Ranking System and a qualitative evaluation of potential exposure to an onsite occupational receptor. Using this and other information suggesting current or potential risks, the *200 Area Soils Remediation Strategy - Environmental Restoration Program* (DOE-RL 1996a) and the *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997) organized the waste sites into groups and determined action (i.e., characterization) is necessary to further delineate current and potential future risks. These initial efforts helped determine the first six waste site groups to be characterized.

5.5.1 Risk Assessment Approach

Assessment activities under the integrated RCRA and CERCLA approach for the 200 Areas are planned to include a work plan, characterization, RI report, FS, and proposed plan to be performed for each waste site group. These activities will lead to a ROD and will be based on characterization data obtained from typical and worst-case representative sites, and TSD units, within the waste site group. Following receipt of the ROD, a confirmatory sampling effort will be performed as part of the remedial action to (1) ensure that characterization data are available for all sites within a group, (2) verify that site-specific contaminant distributions are consistent with the conceptual model for the group, and (3) support remedial design.

5.5.1.1 Qualitative Risk Assessment. A qualitative risk assessment will be performed as part of the RI report and FS. The qualitative risk assessment will use historical process and characterization data as well as data collected from the representative site characterization activities. This data set will be sufficient to evaluate the remedial alternatives and ultimately the selection of a remedial action. However, data will not be collected at this time for all the waste sites within a waste site group, but rather will be limited to a few selected sites (i.e., representative sites). Thus, a quantitative risk assessment would generally not be performed as part of the RI/FS activities. However, a limited quantitative risk assessment may be performed at the RI/FS stage if a more complex situation occurs where a large data set is required to be collected due (for example) to multiple waste site interactions, higher levels of contamination requiring more data to be collected, or other drivers where a more detailed evaluation is needed for a specific waste site or location. A qualitative risk assessment would generally not be performed for an entire waste site group.

5.5.1.2 Quantitative Risk Assessment. A quantitative risk assessment will be typically performed once additional data become available for all the waste sites in a waste site group. A quantitative risk assessment will require a sufficient data set to allow for detailed modeling. This may be accomplished possibly as early as the collection of the confirmation data after the ROD, but would typically be performed once the remedial action is completed.

Guidance by the EPA indicates that action is generally warranted at a site when the cumulative carcinogenic risk is greater than 10^{-4} or the cumulative noncarcinogenic hazard index exceeds 1.0 based on assumptions of reasonable maximum exposure. When the cumulative current or future baseline cancer risk for a medium is within the range of 10^{-6} to 10^{-4}, the conceptual model must be examined to determine if further action is necessary. Risk below 10^{-6} is regarded as a point of departure below which no action is taken.

Under MTCA, risk assessment requirements for cleanup and verification for non-radioactive contaminants stipulate that carcinogenic risk shall be less than 10^{-6} for individual contaminants and less than 10^{-5} for cumulative risk for multiple contaminants and/or multiple exposure pathways. Concentrations of noncarcinogenic chemicals that may pose acute or chronic toxic effects on human health shall not exceed a hazard quotient of 1.0 and a cumulative hazard index of 1.0. Achieving these MTCA based risk ranges applies to non-radioactive contaminants. Ecology is presently using the EPA 15 mrem/yr above background as the radionuclide cleanup standard.

5.5.2 Risk Assessment Implementation

In general, extensive historical process information is available for 200 Area waste sites. However, availability of contaminant-specific data is much more limited. Characterization data will be collected through the implementation of the analogous site approach as outlined in future group-specific work plans. Once characterization efforts at a waste site are completed, a risk assessment will be performed to further delineate current risks posed by a waste site or a waste group. The objective is to better understand site risks in order to determine the need for remedial action and to prioritize future remedial action. This objective can be realized by use of either a quantitative or qualitative risk assessment as discussed in Sections 5.5.1.1 and 5.5.1.2.

It is envisioned that the final stage of risk assessment, as applied to 200 Areas' characterization and remedial action activities, will be the most rigorous and formal. Typically, its purpose will be to evaluate the cumulative risk posed by individual sites (or the 200 Areas' sites in total) to declare that remediation is complete and close out the sites (or the 200 Areas). These risk assessments will be quantitative in nature. Using all the information available, these risk assessments will be designed to account for all potential cumulative risks under future exposure scenarios. It is expected that the characterization data collected as part of the 200 Areas characterization strategy (Section 6.2) will support such an effort.

5.5.3 Sequence of Risk Assessment Activities

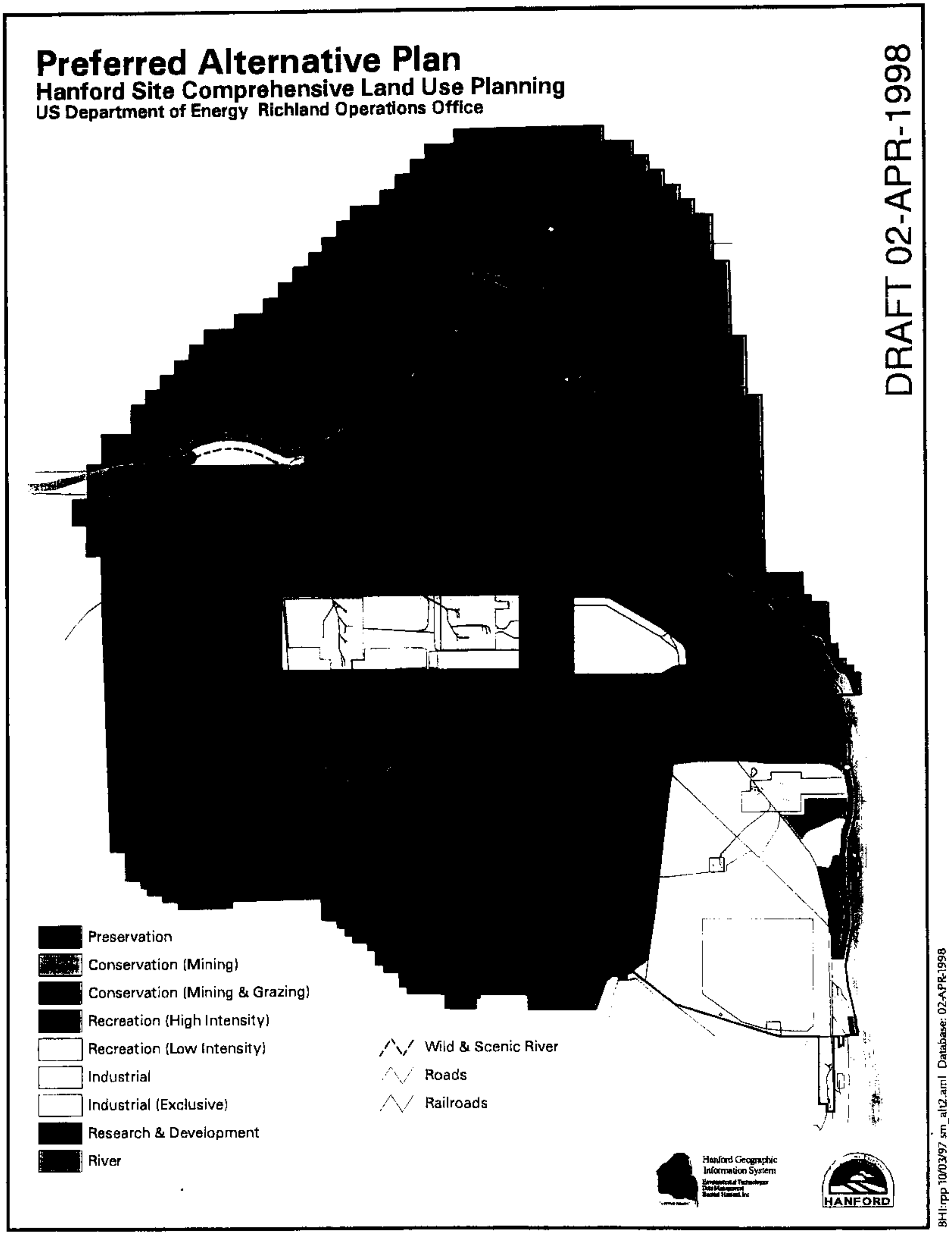
The sequence of activities anticipated for the 200 Area ER waste sites is as follows:

- The first six waste groups are generally considered to be low-activity, medium- to high-volume waste sites. Often a sufficient volume of liquids has been disposed at these types of waste sites to cause contamination to have historically impacted groundwater. Conceptually, these types of waste sites are expected to be simple in nature, where existing contaminant distribution concepts apply. Where contaminants remain at significant levels in the vadose zone, a qualitative risk assessment (typically a one-dimensional model such as RESRAD) will be used during the RI/FS phase.

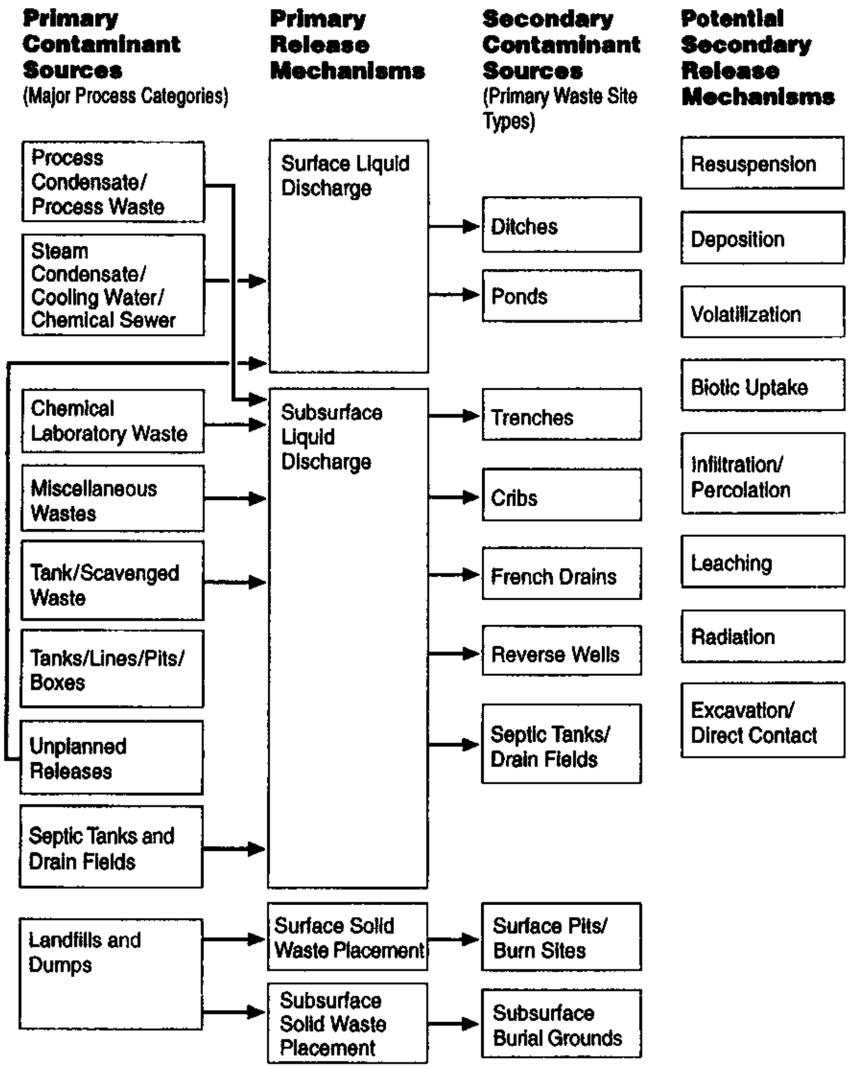
- Although not specifically defined at this time, the characterization of the next set of waste groups could involve sites that received smaller volumes or more highly concentrated or complex wastes or waste sites in close proximity to other waste sites with complex conditions such as the Tank Waste Remediation System (TWRS) tank farms. In order to address complex conditions, a more detailed risk assessment may be needed during the RI/FS stage provided sufficient data will be available to support the more rigorous analysis. This risk assessment could be considered a limited quantitative risk assessment focusing on a single or few waste sites, but would not be sufficiently comprehensive to be considered a cumulative risk assessment. Thus, a more detailed two-dimensional model (or simplistic three-dimensional model) may be required to support this effort.

- A cumulative quantitative risk assessment is anticipated to be performed once sufficient data have been collected to allow a comprehensive (area-based) evaluation to be performed, as well as once final remedial actions have been defined and end states established. Any cumulative risk assessment that is required to establish cleanup standards other than those contained in the current regulations is not considered on a waste site-specific basis and must be considered at a site-wide level. Coordination and integration of this activity through the Groundwater/Vadose Zone Integration Project is discussed further in Section 7.3.1.

Figure 5-1. DOE Preferred Land-Use Alternative[1].



[1]Presented in HRA-EIS. (DOE 1998)



Potentially Contaminated Media	Potential Exposure Routes	POTENTIAL RECEPTORS: Humans – Current Worker	Humans – Future Worker	Humans – Occasional User	Biota – Terrestrial	Biota – Aquatic
Sediments	Ingestion	●	●	●	●	●
	Dermal Contact	●	●	●	●	●
	External Radiation	●	●	●	●	●
Surface Soils	Ingestion	●	●	●	●	–
	Dermal Contact	●	●	●	●	–
	External Radiation	●	●	●	●	–
Subsurface Soils	Ingestion	●	●	–	●	–
	Dermal Contact	●	●	–	●	–
	External Radiation	●	●	–	●	–
Air/Soil Gas	Inhalation	●	●	●	●	–
Biota	Ingestion	–	–	–	●	●
Groundwater	Ingestion	–	–	–	–	–
	Inhalation	–	–	–	–	–
	Dermal Contact	●	●	–	–	–
	External Radiation	●	●	–	–	–
Surface Water (Columbia River)	Ingestion	–	–	●	●	●
	Dermal Contact	●	●	●	●	●
	External Radiation	●	●	●	●	●
Solid Wastes/ Debris	External Radiation	●	●	●	●	–

LEGEND

● Complete exposure pathway

– Incomplete exposure pathway

E9803078.1

Figure 5-2. Conceptual Model for the 200 Areas.

6.0 DATA QUALITY OBJECTIVES PROCESS AND CHARACTERIZATION REQUIREMENTS

This section presents a consistent approach to data collection activities associated with 200 Area assessment and remediation activities. The activities include all phases of sampling required to support the completion of the integrated RCRA/CERCLA process outlined in Section 2.3 and depicted in Figure 2-2. Specific activities include:

- Data collection at representative sites defined for the waste group-specific work plan with an emphasis on verifying the conceptual model. This will support preparation of a focused feasibility study and the remedial action decision making.
- Data collection after the ROD to confirm that all other sites in the specific waste group meet the conceptual model. In addition, data collection activities will be included as part of the remedy selected for the waste group and will provide site-specific information for preparation of the remedial design/remedial action (RD/RA) work plan.
- Data collection as defined in the RD/RA to verify that remedial actions associated with a remove, treat, dispose remedy have met the required objectives.
- Data collection defined as part of the post-closure monitoring plan section in a closure plan for a RCRA TSD unit or RPP site. For CERCLA sites, remedies where waste is left in place and a barrier cover is installed may include an operations and monitoring plan that requires specific monitoring activities to demonstrate adequacy of the design.

The characterization strategy is designed to optimize all phases of data collection activities. The DQO process provides the foundation for a data collection activity and is presented in Section 6.1. This section provides a basic description of the DQO process that will be used to create a consist design of data collection for all phases of the characterization strategy.

The characterization strategy presented in Section 6.2 is designed to address the multiple phases of data collection in the field in a more streamlined process. The strategy uses valuable experience from previous characterization activities to focus data collection plans on the most cost-effective technique. It also requires a periodic review of advances in technology for sample collection, site monitoring, or analytical techniques to ensure continuous improvement.

The individual sections listed below provide detailed discussions of the elements of the characterization strategy that are expected to form the basis for data collection activities during the remediation of the 200 Areas waste groups.

- Characterization strategy
- Approach for characterization of representative sites
- Confirmation of the analogous site concept and collection of remedial design data
- Verification sampling
- Characterization techniques and emerging technologies
- National *Environmental Policy Act* (NEPA) values associated with characterization.

6.1 DATA QUALITY OBJECTIVES PROCESS TO SUPPORT THE CHARACTERIZATION STRATEGY

The DQO process (EPA 1993) is a planning approach, based on the scientific method,13 that provides a systematic procedure for defining the criteria that data collection should satisfy, including when, where, and how to collect samples, the number and quantity (e.g., volume) of samples, and the type and quality of analyses. The DQO process will be started before, or in parallel with, preparation of each group-specific work plan for each waste group. The DQO process will include group-specific project leads from EPA, Ecology, and DOE, with support by ERC personnel. The DQO process will be used as a planning tool for each group-specific work plan.

The DQO process provides assurance that the type, quantity, and quality of environmental data used in decision making will be suitable for the intended application. It establishes a consistent, cooperative, and streamlined approach that encourages the optimum use of available data and technical resources. The DQO process will take advantage of the characterization strategy outline in Section 6.2 to optimize data collection from characterization through the verification that RAOs have been achieved.

The DQO process consists of seven steps. The output from each step influences decisions that are made in the other steps. Even though the DQO process is typically depicted as a linear sequence of steps, in practice it is iterative; the outputs from one step may lead to reconsideration of prior steps. This iterative process to DQO developments leads to a more efficient data collection design. The seven steps that comprise this process include:

Step 1. State the Problem
Step 2. Identify the Decision
Step 3. Identify the Inputs to the Decision
Step 4. Define the Boundaries of the Study Area
Step 5. Develop a Decision Rule
Step 6. Specify Limits on Decision Error
Step 7. Optimize the Design for Obtaining Data.

The foundation of the DQO process is the collection and organization of historical information, existing analytical data, and other relevant information into a report that is readily accessible by the DQO participants. The information gathered and evaluated as part of this scoping process serves as the basis for much (but not all) of the inputs required to complete the DQO. During the first six steps of the DQO process, the DQO participants (regulators and DOE as decision makers with technical support as required) develop the DQOs necessary to support environmental decision making. The final step of the process involves developing the data collection design based on the DQOs.

The DQO process is enhanced and simplified through the use of an electronically-formatted workbook that includes introductory material, a list of activities that will be performed, and a series of input boxes to assist the participants. The workbook is designed to provide a user-friendly system to prepare for DQO workshops, record information and decisions developed, and document the process.

The outcome of the DQO process will be the establishment of the agreed-upon environmental measurements (type, quantity, quality) needed to support remediation/closure alternative decisions. The DQO workbook is issued as the project DQO process summary report. Portions of the completed workbook are incorporated into the SAP, which will aid in the data quality assessment (DQA) process. The DQA process is the scientific and statistical evaluation of the data collected to determine whether

13 The scientific method involves the principles and processes regarded as characteristic of or needed for scientific investigation, including rules for concept formation, conduct of observations and experiments, and validation of hypotheses by observations or experiments.

they are of the right type, quality, and quantity to support characterizing human/environmental risk and/or cleanup decisions. The DQA process is performed at the conclusion of each sampling event and is used to direct future sampling events.

6.2 CHARACTERIZATION STRATEGIES

This section describes general characterization strategies to be employed during data collection activities at 200 Areas waste sites that are defined by the DQO process. The data collection activities include:

- Initial characterization of representative waste sites and TSD units within a waste group
- Remedy confirmation and remedial design at individual sites within each waste group
- Verification of effectiveness of the remedy at each waste site after completion of the remedial action(s)
- Post-closure monitoring at sites where residual waste remains after completion of remedial actions.

Also included is a discussion of proven characterization techniques, potential new technologies that can be used to achieve timely and cost-effective collection of the required data, and the NEPA values associated with characterization.

Characterization strategies are closely tied to waste disposal history, waste stream chemical composition, the physical structure of the waste site, and the underlying geology. Based on waste site configuration and characterization requirements, experience from previous 200 Areas characterization activities has shown certain field investigation techniques and technologies will be appropriate for the optimal data collection. Characterization strategies have as their primary focus the determination of the nature and extent of contaminants and the physical and chemical properties of the contaminated media (e.g., soil). Characterization data serve to refine conceptual exposure and contaminant distribution models and define remedial action needs.

6.2.1 Characterization Strategy

The characterization strategy that shapes the application of the DQO process uses a phased approach that collects data to (1) understand the physical contaminant distribution models of the waste site contamination; (2) support the evaluation of remedial alternatives; and (3) select a remedy, and support the design of the remedy. As the project progresses, historical and newly collected data are evaluated to support decisions or determine additional data needs. In general, the strategy envisions three phases of data collection:

1. Collect initial characterization data at the representative waste sites and TSD units within a specific waste group to adjust and/or verify the physical contaminant distribution conceptual model and support remedy selection.
2. Collect confirmation data at individual waste sites within a specific waste group to ensure that the remedial alternative is appropriate and to support the remedial design.
3. Collect verification data at individual waste sites to determine that the remedy was effective after completion of the remedial action.

The process for grouping individual waste sites into waste groups is based on similar process or sites (e.g., analogous site approach) and supports the use of representative sites to optimize use of process knowledge and previous site investigations to determine the data needs for the initial characterization phase. Characterization requirements, regardless of the phase, are defined as part of the DQO process. Data are generally needed for the following:

- Physical contaminant distribution model refinement
- Treatability tests
- Risk assessments
- Remedial alternatives evaluation
- Waste inventory estimates.

It is expected that characterization requirements will focus on chemical and physical soil contaminant data (including contaminant mobility as the foundation for subsurface data). Contaminant chemical data, including site-specific chemical and/or radionuclide analyses of affected media, will be needed to assess the nature, extent, and level of contamination. Physical properties, including geologic structures, particle size distribution, unsaturated hydraulic conductivity, and moisture content, are obtained from sampling during manpower-intensive drilling or trenching operations. These properties, as needed, will be used with contaminant characteristics (e.g., mobility and persistence) to assess the fate and transport of contaminants. Fate and transport analytical models (computer codes) may be used to facilitate this assessment. As the certainty of the physical and contaminant distribution model increases, based on the phase 1 sampling of representative sites, less intrusive methods such as cone penetrometer/geoprobe testing and more indirect (nonintrusive) data collection techniques (soil gas vapor, borehole geophysics) will be used to guide decisions on remedial design (phase 2) and final verification (phase 3).

One of the inherent checks is that data will be continuously evaluated for uncertainty and adequacy to support decision making or to determine additional data needs. The number of samples required during subsequent waste group DQOs can be optimized to eliminate the collection of redundant data.

The characterization effort for each waste group will always include the RCRA TSD units listed as part of the group. The inclusion of the RCRA TSD units will allow the specific sampling required to meet RCRA TSD closure requirements and to develop the closure strategy for that specific unit and its ancillary equipment. In the 200 Areas, RCRA TSD units that were clean closed generally were not evaluated for radionuclides, because radionuclides are to be addressed by the CERCLA program. Additionally, hazardous substances and dangerous waste constituents that were not managed by the TSD unit will also be characterized.

While the exact interplay between the RAOs and remedial alternatives will be found in group-specific work plans, the following basic principles apply (as discussed in Section 5.3):

- RAOs related to protection of workers and the environment primarily focus characterization activities on surface and near-surface soils, and are concerned with areal extent as well as hot-spot locations.

- RAOs related to the protection of groundwater focus characterization on significant subsurface inventories and distribution through the vadose zone. Because contaminant migration potential and driving force to groundwater is a concern, more information on the physical and chemical properties of the soils and interaction with contaminants is required.

For example, an RAO designed to protect workers from inhalation hazards would focus characterization on surface soil that would most likely be disturbed through resuspension mechanisms. If excavation of piping is expected, for example, then the concentrations of contaminants within the near surface zone would be required to calculate the potential impact to the workers. In this case, since the mechanism for exposure is predominately physical in nature, related to effects from resuspension due to the wind, less information about soil transport properties is required.

For RAOs designed to protect groundwater, characterization is focused on vertical distribution of the contaminants potential driving forces, retardation, physical properties of the contaminants, and how these interact to move contaminants through the vadose zone. If needed, data would be collected to provide modeling inputs to predict the transport of contaminants over time and the projected impact on groundwater.

6.2.2 Approach for Characterization of the Representative Sites

An important feature of the characterization approach is the application of biased sampling. Bias in sampling is the intentional location of a sampling point within a waste site based on process knowledge of the waste stream and expected behavior of the contaminant(s) of concern. Using this approach, a sampling location can be selected that increases the chances of encountering worst-cast contamination conditions in the soil column. This is used to determine the concentrations and distributions of potential contaminants of concern, when there is adequate information to make it a reasonable approach. The bias approach is well suited for the majority of waste sites that received liquid waste streams since their construction tends to provide a predictable pattern of contaminant distribution.

As an example, one type of crib designed in the 1950's consisted of a rectangular excavation within which the influent discharge cascaded through a series of up to three wood or concrete boxes. This resulted in a cascade effect where the majority of liquids and, therefore, contaminants infiltrated in the first cascade, with very little in the second or third. By using bias sampling in the first cascade, a realistic worst-case determination of the vertical distribution of contaminants can be obtained. The bias approach is also supportable by available nonintrusive geophysical methods such as spectral gamma logging in adjacent dry wells or groundwater monitoring wells.

While there is not always a direct correlation with the contaminant distribution models generated for specific sites, traditional statistical analyses may miss significant levels of contamination due to the strong vertical gradient for most contaminant migration and the selective manner in which the liquid was introduced into the site. The statistical sampling design in this early phase of characterization is limited by insufficient data on the distribution of contaminants and the fact that contaminants do not tend to randomly distribute. Therefore, these designs tend to be more costly than bias sampling, which benefits from the historical information that has been collected on the operation of the site and field experience gained from past investigations.

Examples of selected past investigations for various waste sites based on the biased approach are summarized in Table 3-11. The summary is provided to outline the general process and techniques applied to characterize waste sites. In general, conceptual models and contaminant distribution model(s) developed for the 200 Areas based on these investigations suggest there are similarities in the distribution of contaminants among groups of similar liquid waste sites, as described in Section 3.3. The models suggest that:

- Maximum contaminant concentrations are generally detected at the point of discharge or near the bottom of waste sites. Typically, the highest concentration of contaminants (such as plutonium, cesium, strontium, and other contaminants with moderate to low mobility) are detected within several meters of the bottom of the structure. When the volume associated with the discharge is low, contaminants with higher mobilities would also be within several meters of the structure bottom. These higher concentrations are generally seen at the bottom of ponds, ditches, trenches, and cribs (see Table 3-11). In reverse wells, the highest concentrations are near the point of discharge. Most of the moderate to low mobility contaminants that remain at a waste site are within several meters of these locations. The only significant exception to this is carbon tetrachloride, due to its multi-phase flow capabilities.

- At liquid waste sites with high-volume flow, highly mobile contaminants have moved through the sediment and impacted the groundwater. Since the majority of contaminants have already passed through the vadose zone, only trace concentrations remain in the vadose zone.

- Contaminant concentrations typically decrease with depth. However, elevated levels of contamination may be detected within and just above fine-grained layers (retarding strata) with low hydraulic conductivities or silt/clay layers.

- Contaminant transport is primarily vertical beneath liquid waste sites. Lateral spreading is usually limited although, in some cases, it can be significant with high-volume waste streams and significant aquitards.

While experience in the majority of cases is consistent with these models, site-specific anomalies may circumvent the distribution of contaminants through the presence of preferential pathways. Poorly sealed wells and continuous clastic dikes may provide preferential pathways and increase the vertical extent of contamination.

6.2.3 Confirmation of the Analogous Site Concept and Collection of Remedial Design Data

It is expected that the characterization data for representative waste sites will provide sufficient information to select remedies for the waste site group being considered. However, site-specific data are needed to verify that the selected remedial alternatives are appropriate. Confirmation data for individual waste sites can serve as both a validation that the selected remedial alternative is appropriate for the waste site and provides a basis for remedial design.

The collection of confirmation data is expected to be based on a biased approach to optimize the collection of data and be cost effective. While the confirmation process is specific to each site and remedy, it will generally include the following:

- Validate that the individual waste site conceptual model is consistent with the waste group
- Determine waste site distribution of contaminants
- Provide required remedial design inputs (e.g., volume of affected media)
- Provide input to risk assessments.

In the event that the data for a specific waste site do not support the remedial alternative selected, the site will be reassigned to a waste group more closely aligned with its characteristics. Additional confirmatory sampling may be required if a site is reassigned.

The methods for data collection will be similar to those used in the initial characterization of representative sites. Documents will be generated based on the waste group-specific work plans. A DQO focusing on the waste group-specific work plans, and supplemented by requirements to support the remedial design, will be performed to generate a verification SAP to direct confirmatory sampling efforts.

6.2.4 Verification Sampling

The verification sampling approach will be dependent on the type of remedial alternative selected. Remedial alternatives that involve remove, treat, and dispose options require data collection at the completion of remediation to verify that the RAOs for the specific waste site were achieved. RCRA closure actions will require verification sampling to determine to what level removal and decontamination of dangerous waste or waste residues at a site has been achieved pursuant to WAC 173-303-610 (2)(b). Verification sampling will form the basis for the closure option that must be implemented at the site, i.e., clean closure, modified closure, or landfill closure as described in Section 2.2.1. The verification sample design is typically based on information collected during the remedial action (e.g., field screening data). Verification sampling will evaluate contaminants that might remain upon completion of the remedial action. Verification sampling is typically statistically based, and optimized to limit the number of RCRA protocol samples required. Optimization involves the use of field screening techniques and a review of data collected during remedial action.

Based on lessons learned from the 100 Area remediation experience, indicator species have been found to be useful as a part of the remove/treat/dispose actions. Radioactive or chemical indicator species are chosen to be a target analyte for a larger class of constituent analytes with similar mobilities, geochemical properties and associations. The indicator species simplifies and economizes on sampling activities, usually at the stage of waste site remediation or verification. By being easily detected with relatively simple field screening equipment, to low concentrations, and backed up with more rigorous sample data, the indicator can show that one or more additional constituents are present within a given range of concentration, relative to that of the indicator. The field screening data must be supported with defensible analytical data that show that assumed correlations and concentrations ratios between indicator and representative species, are in fact true. The indicator must be demonstrated to show, before any fieldwork is done, that assumed relationships between the species are true for all sites in question. And, confirmatory sampling must be performed after the fact to show that the indicator's use was appropriate. That is, confirmatory sampling must demonstrate successfully that the extent of the indicator species was equal to or greater than the extent of the represented species.

Since most contaminants are collocated with other contaminants, Cs-137 can be used as an indicator in guiding the excavation of contaminated soil. Other contaminants, such as beta emitters Sr-90, Ni-63, and U-238, are not easily detectable with direct-reading instruments at low levels, but since they are usually located with Cs-137, the contaminated soil can be identified and removed.

Surveys for Cs-137 guide day-to-day excavation activities by delineating contaminant plumes and providing information regarding the location for collecting ex-situ samples for rapid turnaround analysis. Use of in-situ radiological surveys minimizes the collection of ex-situ samples during the ongoing excavation process. The data from these measurements provide a basis for determining the distribution of contaminants and allow a cost-effective design for collecting full RCRA protocol verification samples. For remedial alternatives that involve no action, institutional controls, or surface barriers, the verification process would involve some form of ongoing monitoring to establish that exposure controls have been achieved or that contaminants are not migrating. This type of verification is specified in a post-remedial action operations and maintenance or post-closure plan and may include the following:

- Periodic site inspections
- Installing groundwater monitoring wells and periodic groundwater sampling
- Measuring airborne environmental radiation contaminant

- Installing vadose zone monitoring wells and periodic nonintrusive monitoring of contaminant migration and/or moisture content.

The site-specific verification strategy will be developed in the remedial design for each waste site based on the ROD and any subsequent conditions from the Hanford Facility RCRA permit.

6.2.5 Characterization Techniques and Emerging Technologies

Characterization methods at the Hanford Site combine intrusive and nonintrusive techniques. Characterization must consider proven methods and potentially applicable new technologies. Sections 6.2.5.1 through 6.2.5.5 discuss characterization methods successfully used in previous Hanford Site investigations. Section 6.2.5.6 presents information on promising new technologies.

6.2.5.1 Borehole Drilling. Borehole drilling is used to access the deeper vadose zone (9.1 m [30 ft] and beyond) to collect soil samples for direct analysis. Cable tool, air rotary and sonic, are commonly used drilling methods at the Hanford Site. The selection of these methods for a specific waste site is dependent on sampling objectives, contaminants of interest, soil properties of interest, contamination control issues, and cost.

Cable tool drill rigs use specialized tools to advance the boring to depth and collect representative samples of soils. A drive barrel attached to a steel cable is driven to the required depth with a percussion-type hammer. A sediment sample is collected using a split-spoon sampler. Casing is driven past the sample interval to prevent collapse of the hole. As the casing is advanced in the borehole, additional soil (i.e., slough) is pushed into the borehole from the area sampled. The slough is cleaned out of the borehole, and the process of advancing the boring and sample collection is repeated. Cable tool drilling with a split-spoon sampler typically provides samples more representative of the selected interval, and improved contamination control since the material is contained within the drive barrel or split spoon as it is removed from the borehole. Site-owned cable tool rigs are more appropriate for use in areas of higher radiological contamination because of the high cost of decontaminating and releasing contractor-owned drill rigs. This system has significant mobilization and demobilization costs, slow advancement of the borehole to depth, and captures only a very small cross-section of the waste site.

Air rotary systems use a drive hammer to drive drill string into the subsurface and compressed air to bring soil cuttings to the surface. Samples collected from the soil and air stream using this method are of poorer quality because air may strip off contaminants. However, air rotary systems can use a split-spoon sampler. When the sample interval of interest is reached, the drill bit is removed from the drill string and the split-spoon sampler installed. This process does slow down the advancement of the borehole, but overall the operation of the air rotary system provides better rates of penetration than cable tool drilling. It does require significant mobilization and demobilization costs, and contamination control requires additional high-efficiency particulate air (HEPA) filtration systems when contamination is present because air is used to circulate rotary samples to the surface.

The sonic drilling system uses a combination of mechanically generated vibrations and rotary power to drive the drill string through the soil. To advance the well to depth, soil is forced into the drill string through an open-face core-type drill bit and contained within an inner tube. When the inner tube is filled with soil, it is removed by a wireline retrieval system and provides a continuous core of the formation. The penetration rate of this system is excellent. However, recent concerns concerning sample integrity have limited it's use onsite. For example, sonic drilling may produce high temperatures at the bottom of the drill string that may volatilize organic compound of interest. Sonic core barrel samples in many cases also show evidence of having expanded during drilling (e.g., the amount of sample recovered during drilling may be greater than the length of the area drilled: 1.5 m [5 ft] is drilled; 3 m [10 ft] is recovered).

This could impact the collection of representative samples for determination of soil physical properties. It is more rapid than cable tool drilling, but shares the higher mobilization and demobilization costs with the other drilling methods.

6.2.5.2 Test Pit Construction/Trenching. Test pits are shallow, concave-shaped excavations that can range from 7.6 to 9.1 m (25 to 30 ft) deep depending on the equipment used and the type of soil encountered. The pits are excavated using a back-hoe or track-hoe, depending on the required depth. Samples are collected directly from the bucket and can be representative of as little as 152 mm (6 in.) layers of contaminated soil. With proper care to minimize sloughing of material from above, this sample collection method can be as good as borehole samples. These samples are excellent for pinpointing hot spots and assessing vertical extent of contamination at a waste site.

A related excavation technique is called trenching. Trenching is a test pit extended laterally across a waste site. Trenching provides the ability to locate suspected waste sites, determine their shape, and assess the lateral extent of contamination.

Either technique provides a direct visual confirmation of stratigraphy, allows optimum collection of samples, and is cost effective since it requires minimum site mobilization, and is designed to be completed within one day.

6.2.5.3 Cone Penetrometer/Geoprobe. The cone penetrometer system consists of special drill rods that are hydraulically pushed into the subsurface. The geoprobe system drives the same type of drill rods with a hydraulic vibratory hammer. Both methods differ from drilling in that soil is not excavated to advance the drill rods to depth. As the drill rod is driven into the ground, soil is forced aside to provide subsurface access. Both systems are very versatile. Depending on the type of rod selected, a wide range of data and/or samples can be collected. Capabilities include:

- Collection of soil gas samples
- Measurement of geophysical properties
- Collection of soil samples (limited volume)
- Measurement of gross gamma radiation
- Collection of perched groundwater samples.

In addition, because the cone penetrometer is basically a delivery system, it can accept new measurement techniques as they are developed. The geoprobe system is available onsite, while the cone penetrometer would need to be accessed through a subcontractor.

Either method can be a cost-effective tool for quickly defining the lateral and vertical extent of contamination at a waste site. Each has a limited depth of penetration. The small-diameter/small-volume cores that are collected are not representative of the grain size and are of insufficient volume for extensive laboratory analysis. At the Hanford Site, the maximum depth of penetration is about 36.6 m (120 ft) under ideal conditions (e.g., sand with some gravel). The maximum depth of penetration in a gravel unit is less than 12.2 m (40 ft). Based on field experience, over 50% the cone pushes do not reach their target depths due to obstructions (e.g., rocks or compacted zones). Groundwater samples are generally of poor quality, and data from these samples are used mainly to support the placement of permanent monitoring wells. The mobilization cost is low and the systems can accomplish multiple rod replacements within a single day.

6.2.5.4 Borehole Geophysics. The use of borehole geophysics to investigate soil properties can provide valuable information about the site. Borehole geophysics is commonly used at Hanford to assess the distribution of gamma-emitting radioactive contaminants and to determine the moisture content in soils. The Radionuclide Logging System (RLS) is used to determine the extent of radiological contamination in the soil column identifying specific gamma-emitting radionuclides and determining lithology based on a known distribution of naturally occurring radionuclides in specific formations. Moisture content is determined using a neutron logging probe. These tools are used in conjunction with existing characterization boreholes or wells and provide a continuous reading of soil characteristics. They are easily mobilized and can log multiple wells in a single day.

6.2.5.5 Surface Geophysical Methods. Surface geophysical methods are nonintrusive tools used to locate shallow 0-6.1 m (0-20 ft) subsurface features or determine surface levels of radioactive contaminants. Methods commonly used at Hanford to determine subsurface features include ground-penetrating radar (GPR), electromagnetic induction (EMI), and magnetics. These methods are commonly used to locate suspected disposal pits, buried materials, utilities, and pipelines. GPR is reliable in most situations and provides the most information of the nonintrusive methods. GPR can be time consuming if the site is very large and requires experienced personnel. EMI and magnetics are excellent reconnaissance tools that are easier to use than GPR.

Methods to measure radioactive contaminants include tractor-mounted beta-gamma detectors (that can be driven over large area sites and provide scale maps with radiation level contours), and portable systems carried by a single person that provide similar capabilities but are useful for small waste sites or where access is restricted. Either method provides a cost-effective alternative to soil sample collection and laboratory analysis.

6.2.5.6 Vadose Zone Monitoring. Techniques are available or under development that may be applicable to monitoring concentration changes or moisture movement at waste sites. These tools are considered appropriate for use after selection and installation of the chosen remedy, and would be implemented under an operations and maintenance plan or a post-closure monitoring plan. They are intended to show the adequacy of a remediation technology selected to prevent movement of contamination already in place. These techniques require a previously constructed installation, typically a single or multiple borehole network, to examine fluid movement potential factors, moisture content, soil gases, or to sample pore liquids. Stephens (1996) provides a good overview of vadose zone monitoring techniques and the data needs they can support.

Geophysical logging techniques are available to interrogate the soil volume around a borehole. As mentioned in Section 6.2.5.4, both gamma detection tools, such as the RLS, neutron probes, acoustic velocity logs, and neutron density logging tools can be used to track soil moisture or radionuclides in the soil column. Analyses of repeated measurements will detect changes in moisture content or radionuclide movement over time.

Cross-hole techniques such as gamma ray attenuation, and tomography tools such as electrical resistance, nuclear magnetic resonance, and X-ray computed devices, offer the potential to detect minor changes in soil moisture in three dimensions with an appropriate borehole array. At the Hanford Site, electrical resistance tomography has been examined and field-tested for application around tank farms (Narbutovskih et al. 1997). The system operates by passing an electrical current through the soil column, which is monitored for changes in resistivity resulting from changes in conductivity, induced by soil moisture fluctuations. Other tomography techniques are in the development stage but have not been widely tested.

Ground-based geophysical techniques are capable of measuring soil moisture using a combination of pre-installed subsurface sensors and surface-based interrogation or data collection systems. Electrical methods use electrodes to apply and receive a current through the soil and commonly measure resistivity changes. The method is best applied to delineate lateral extent over a target area or for depth profiling at a given point. Electromagnetic induction applies an electromagnetic pulse to the soil column and measures the response observed in soil depths from 3 to 60 m, depending upon the spacing of the transmitting and receiving coils. It can be used to measure apparent resistivity changes in the field at a site with uniform undisturbed features. GPR uses electromagnetic pulses in the radio frequency spectrum (10-1,000 Mhz) to detect reflecting soil units and conditions. Moisture content and certain contaminated liquids may be detected by this method. Most surface-based systems are best used as a reconnaissance tool to detect relative moisture conditions and are affected by soil column layering and soil material types.

Lysimetry techniques are also available to measure, in situ, the flow of liquids through a soil column and, potentially, the consequent movement of contaminants. The technique requires isolation of a representative disturbed or undisturbed soil mass from its surroundings. The isolated mass is then fitted to either collect liquids moving through the soil or monitor weight changes in the mass due to moisture additions and evaporation transpiration reductions. Lysimetry is a cumbersome, expensive process capable of providing accurate results at the expense of a considerable investment in time.

6.2.5.7 Characterization Technologies. The ongoing review and implementation of innovative characterization technologies is key to maintaining a cost-effective approach to the characterization of the hundreds of waste sites covered by this implementation plan. The following technologies represent promising examples of innovative characterization tools currently under development. Deployment of these tools is expected in the next 2 to 3 years and should be considered in the group-specific work plans.

- A laser-induced breakdown spectroscopy (LIBS) system, which can perform in situ measurements of metals including selected radionuclides in soils, is under development. The LIBS is delivered by a cone penetrometer to the required depth and performs the in situ measurement from the bottom of penetration to the surface as it is being removed. Although a recent onsite demonstration for the collection of in situ information on lead, barium, and uranium was not successful, LIBS has been shown in principle to be a potentially viable tool.

- A ground-penetrating holography (GPH) system enhances existing GPR technology by providing location and algorithm data that produce a volumetric image of objects beneath the ground surface. A single-channel system was successfully demonstrated at the 618-4 Burial Ground in the 300-FF-1 Operable Unit. The information gained from this demonstration will support the development of a multi-channel real-time system. The existing single-channel system is currently supporting cultural resource investigations at Hanford and can support other GPR activities.

- A pipe explorer system can transport characterization sensors into piping systems that are radiologically contaminated. The system deploys an air-tight membrane into the pipe being inspected. The characterization detector and its cabling enter the membrane and take measurements. Therefore, the potential for contamination of the equipment is minimized significantly. The system can be deployed through pipe constrictions, around 90° bends, vertically (up and down), and in wet conditions. Characterization tools that have been demonstrated with the system thus far include gamma detectors, beta detectors, and video cameras. Alpha measurement capability is also under development. The explorer system can be deployed in pipes as small as 50 mm (2 in.) in diameter and up to 76.2 m (250 ft) long.

- Soil gas sampling has been used to monitor changes in volatile and semivolatile organic compounds at selected waste sites, notably in the 200 West Area, as a means of measuring carbon tetrachloride in the vadose zone. A calibrated infrared photoacoustic spectrometer is being used either in a mobile laboratory or at boreholes to examine concentrations of volatile organic analytes. Sampling networks using existing boreholes and shallow soil probes can examine the volatile organic analyte concentration at desired depths in the soil column.

6.2.6 National Environmental Policy Act Values Associated with Characterization

In accordance with DOE policy and orders, CERCLA documents must, to the extent practicable, incorporate NEPA values. These values include ecological, offsite, socioeconomic, environmental justice, and cumulative impacts. These values are evaluated below with respect to characterization of the 200 Area waste sites. NEPA values related to remedial actions and residual contamination that might remain following remedial actions will be evaluated in group-specific feasibility studies.

Environmental impacts from characterization activities are expected to be minimal. Discharges to the environment would be limited to particulates (both contaminated and uncontaminated) that might be emitted during soil drilling activities. Dust-suppression measures will be used to control particulates. Wastes generated could include drilling fluids, contaminated soil and groundwater, and contaminated equipment and clothing. Contaminated drilling fluids will be either disposed at authorized liquid effluent disposal facilities or solidified and disposed at authorized solid waste management facilities. Other wastes generated during characterization will be designated, packaged, and disposed in accordance with site-specific waste control plans.

Reviews of 200 Area ecological and cultural resources are presented in Appendix F. No threatened and endangered species have been identified within the 200 Areas, and no impacts to ecological resources from general characterization activities are anticipated. Buildings in the 200 Areas have been identified for potential consideration as historic resources, but it is not anticipated that any buildings will be impacted by waste site characterization activities. Site-specific ecological and cultural resource surveys will be conducting before any ground-disturbing fieldwork begins.

Offsite impacts are also expected to be minimal. Air emissions from characterization activities are expected to be very low and located well away from site boundaries; therefore, offsite health impacts from the 200 Areas characterization are not expected. Most, if not all, characterization waste will be disposed at the Hanford Site (e.g., ERDF) rather than taken offsite.

No socioeconomic impacts are anticipated with respect to characterization. The existing Hanford Site work force and local resources would be used to perform characterization. Worker safety during characterization will be addressed in the overall health and safety plan (Appendix B) and activity-specific health and safety plans. Characterization activities are expected to use techniques for which protective measures for workers are readily available.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires that federal agencies identify and address, as appropriate, disproportionately high and adverse human health or socioeconomic effects of their programs and activities on minority and low-income populations. Minority populations and low-income populations are present near the Hanford Site (Neitzel 1997). The analysis of the impacts identified in this Plan indicates that there would be only minimal impacts to the offsite population and onsite workers due to implementation of the proposed action because the characterization would take place in the center of the Hanford Site, the potential releases would be small, and the characterization would be performed by existing Hanford Site workers. Therefore, no disproportionately high and adverse human health or socioeconomic effect to any minority or low-income population is expected from this action.

Characterization activities are not expected to contribute significantly to cumulative impacts of activities in the 200 Areas or at the Hanford Site. Other activities occurring in the 200 Areas are the management of waste in underground storage tanks, management of liquid effluent and solid waste treatment/disposal facilities, and deactivation/decontamination/decommissioning of inactive facilities. The airborne emissions, waste generation, and infrastructure needs associated with characterization are minimal compared to these other programs.

7.0 PROJECT MANAGEMENT AND PROGRAMMATIC INTEGRATION

This section describes the activities necessary to support management and integration of the 200 Area's project to ensure that project objectives are achieved. The objectives of project management during the implementation of the RI/FS plans are to ensure the safety of the work force and the affected environment, direct and document project activities, ensure that data and evaluations meet the goals and objectives of the project, and to administer the project within budget and schedule. Sections 7.1 and 7.2 present a general discussion of the work breakdown structure (WBS) and areas of project management that will be common to all aspects of the 200 Area's project and subsequent group-specific work plans. As DQO workshops are conducted for each of the group-specific work plans as discussed in Section 6.1, the specific scope and schedule elements will be defined. These will result in the development of task-specific project management plans.

Within the 200 Areas there are other ongoing programs that may be affected by ER project activities. It is therefore necessary that the ER project interface with these other programs to ensure that an integrated and consistent approach is followed. This is currently done, for example, during review of excavation permits and site planning reports, and at meetings with other program personnel. Within the ER project, integration needs have been identified at various levels. Section 7.3 discusses the overall approach to integration of the Implementation Plan with other ER programs, Hanford Site programs such as the groundwater/vadose zone project, and other interested agencies or entities.

Section 7.4 provides a general discussion of the schedules for the 200 Area characterization and remedial action. The milestones that have been established for the first six group-specific work plans are presented, as well as a conceptual schedule that addresses the remaining 17 work plans and characterization activities to be accomplished over the next 10 years.

Involvement of the public is recognized as an important and necessary part of DOE activities on the Hanford Site. As group-specific work plans are developed and other ER-related activities occur in the 200 Areas, there will be opportunities for public involvement as discussed in Section 7.5. Additional details on the public involvement process have also been presented in Section 3.3.

7.1 WORK BREAKDOWN STRUCTURE

Work within the 200 Areas is structured to address the approach to remedial actions and assessment (or characterization) activities in a manner that is consistent with other ERC projects. Based on guidance from RL for establishment of a baseline document that establishes the scope, schedule, and budget for the ER project, the use of a detailed work plan (DWP) was adopted. The DWP is a 3-year plan, updated annually, which describes the specific details associated with each project that has been proposed. The DWP is based on milestones defined in the TPA and must reflect the TPA schedule and commitments made therein. It is anticipated that for each group-specific work plan that is to be developed, a DWP will be prepared and approved that will define the scope, schedule, and budget to a level of detail that will be adequate for planning and management of that project. Inherent with this approach is the assumption that a DQO workshop will be held to define the specific scope associated with each waste group and this information will be used to define or refine the information presented in the DWP for that group. The DWP is a planning document for the ERC that rolls into and becomes a subset of the Long-Range Plan. The ERC Long-Range Plan provides an integrated technical, cost, and schedule lifecycle baseline for the various projects within the ERC. It is a tool that is used to forecast activities into the future so that appropriate staffing, funding, and schedule needs can be assessed.

Based on previous projects within the ERC project, a definition of the overall WBS associated with each of the group-specific work plans has been devised. This WBS represents a series of tasks that describe a specific scope of work for the investigation. This framework is consistent with the Hazardous, Toxic and Radiological Waste (HTRW) coding structure that provides a uniform structure for collecting and reporting of costs for the project and is used by all ERC projects. At a higher level these tasks may include the following:

- Preparation of plans
- Field investigations
- Direct project support
- Regulatory/other project interfaces
- Community relations/interfaces
- Document preparation.

Work may be planned, scheduled, estimated, and managed at lower levels or subtasks of the coding structure, depending on management needs. All lower level subtasks must be subparts or elements and roll up to the next level in a hierarchical manner. For example, within the field investigations task, the following subtasks may be included:

- Source characterization
- Vadose zone investigation and monitoring
- Geologic investigation
- Air investigation
- Ecological investigation
- Data evaluation.

7.2 PROJECT MANAGEMENT

This section addresses the basic concepts of project management that occur throughout the life of the project. Specific portions or tasks that will occur throughout the RI/FS process, including each of the group-specific work plans, are described in the following sections. Individuals that are associated with the project and interfaces with other organizations are also described.

Further detail on schedule control, cost control, meetings, and reporting can be found in the *Environmental Restoration Field Office Management Plan* (DOE-RL 1989) and the *Tri-Party Agreement Action Plan* (Ecology et al. 1996).

7.2.1 Project Organization and Responsibilities

The project organization for implementing characterization activities outlined in the 200 Area Implementation Plan is shown in Figure 7-1. The following sections describe the responsibilities of the individuals shown in Figure 7-1. The positions described here have overall management authority for the project. Additional support roles are described in further detail in the project management section of the Quality Assurance Project Plan (QAPjP) in Appendix A.

7.2.1.1 Regulatory Agencies and the U.S. Department of Energy.

Senior Project Managers. The EPA, the DOE, and Ecology have each designated an individual as senior project manager for characterization and remedial activities at the Hanford Site. These senior project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement. The responsibilities of the senior project managers are given in Section 4.1 of the Tri-Party Agreement.

Project Managers. As shown in Figure 7-1, the EPA, the DOE, and Ecology will each designate an individual to act as the project (or unit) manager for each of the 23 waste groups or operable units. The EPA and Ecology have decided on which organization will serve as the lead regulatory agency for each of the waste groups as reflected in Table G-1 of Appendix G. These decisions will be reflected in Appendix C of the Tri-Party Agreement.

The project manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology project managers informed as to the status of the activities in the 200 Areas, particularly the status of agreements and commitments.

7.2.1.2 Contractor Support Staff.

Project Manager. On behalf of the DOE, the ERC Remedial Action and Waste Disposal (RAWD) Project also provides a project manager who has the overall responsibility for safe and successful execution of the project. The principles and responsibilities discussed in the *Remedial Action and Waste Disposal Project Manager's Implementing Instructions* (PMII) (BHI 1998) are used by all key personnel. All key personnel assigned to management roles within the RAWD Project must ensure compliance with these PMIIs and are responsible for implementing these principles with project staff.

200 Area Task Lead. The task lead shall be assigned by the RAWD Project and is responsible for management and identification of functional support needs of the project. The task lead works closely with project controls, quality assurance, health and safety, and the field engineer to ensure that work scope is being performed in accordance with each of these areas of responsibility. The responsibilities of the Bechtel Hanford, Inc. (BHI) 200 Area task lead will also be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound. Other duties include coordination of communications with the DOE, the EPA, and Ecology. The task lead reports to the RAWD project manager and the DOE project manager.

Preselected Subcontractor Support. Staff from the preselected subcontractor will support the performance of assessment-related activities, including items such as generation of group-specific work plans, RI/FS documents, field activities, sample and data analysis, risk assessments and modeling that may be required, remedial alternatives assessment, and proposed plans. The preselected subcontractor will keep the 200 Area task lead informed as to the work status and any problems that may arise, and will participate in any long-range planning activities related to these areas. Preselected subcontractor staff will also support preparation of closure and post-closure plans for any TSD units that are to be addressed within a waste group, along with proposed permit modifications. This includes coordination of any field activities with planned RI/FS activities.

BHI Functional Support Groups. The project shall use the services of additional personnel as required to manage and control the project. These individuals may include a quality assurance representative, health and safety officer, project engineer, field superintendent, and an environmental lead. In addition, staff may be supplied from support organizations such as waste management, sample and data management, radiological controls, and planning/integration. The roles of some of these individuals are described further in Appendix A.

7.2.2 Work Control

The primary goals of the ER Project *Baseline and Funds Management System* (BFMS) (ER-PC-01) are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget. The BFMS is to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements. BHI will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a subcontractor is used, BHI will maintain overall project management responsibilities. The management control system used for this project must meet the requirements of DOE Order 4700.1A, "Project Management System." The ER Project BFMS (ER-PC-01) was developed to meet these requirements.

7.2.2.1 Cost Control. Project costs, including labor, other direct costs, and subcontractor expenses (e.g., drilling and laboratory analyses), will be assessed monthly. The budget tracking activity is computerized and provides the basis for invoice preparation and review, and for preparation of cost performance reports. These reports assess the status of each project task against projected budgets, determine performance, and report any corrective actions that may be required. Any adjustments to budgets are controlled through a formal management process, which includes use of baseline change proposals to modify baseline budgets. The DOE project manager will update the EPA and Ecology project managers of their respective project costs to date (i.e., for their operable unit, waste site group, and/or TSD units) at monthly unit managers meetings.

7.2.2.2 Schedule Control. Scheduled milestones will be statused, at a minimum, on a monthly basis for each task on a given project. This will be done in conjunction with cost performance reports associated with cost tracking. Work plan milestones will also be statused monthly at unit managers meetings.

The lifecycle or total project schedule developed for the 200 Areas will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming fiscal year in conjunction with preparation of the DWP. Individual group-specific work plan schedules are detailed in the DWP and are summarized at a higher level of WBS in the Long-Range Plan. In this manner the lifecycle schedule for the 200 Areas is considered in the long-range planning efforts for the ERC project.

7.2.3 Meetings

Project managers (DOE, EPA, and Ecology) will meet monthly at unit managers meetings to discuss progress and project costs, address issues, and review near-term plans pertaining to their respective operable units and/or TSD units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE project manager for the operable unit will be responsible for preparing revisions to the schedule prior to the meeting. The schedule shall address all ongoing activities associated with an active operable unit. This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the project manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Unit manager meeting minutes will be issued by the DOE project manager and will summarize the discussion at the meeting, with information copies given to the project managers.

Other meetings will be held, as necessary, with subcontractors and other appropriate entities (particularly those involved with other programs operating in the 200 Areas) to communicate information, assess project status, and resolve problems.

7.2.4 Records Management

The Tri-Party Agreement specifies documentation and records management requirements for remediation activities at the Hanford Site. The Tri-Party Agreement categorizes all supporting documents based on importance of documenting final data or use in decision making to support remediation. Under the Tri-Party Agreement, documents are categorized as either primary or secondary documents. Tables 8-1 and 8-2 of the Tri-Party Agreement provide a listing of primary and secondary documents, respectively.

The Tri-Party Agreement describes the process for review, comment, and revision of documents supporting cleanup of an operable unit. The Information Management Overview, Appendix C of this document, details ER and Hanford Site programs for records management. As noted in Subsection 7.2.2.2, the 200 Area project managers are responsible for implementing Tri-Party requirements for characterization and remediation of the 200 Areas. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement. The Administrative Record will be maintained to support 200 Area characterization activities in accordance with Section 9.4 of the Tri-Party Agreement.

The project file will be kept organized, secured, and accessible to the appropriate project personnel. All field reports, field logs, health and safety documents, QA/QC documents, laboratory data, memoranda, correspondence, and reports will be logged into the file upon receipt or transmittal.

7.2.5 Progress and Final Reports

Monthly progress will be documented at unit managers' meetings. Meeting minutes will be prepared, distributed to the appropriate personnel and entities (e.g., project managers, coordinators, contractors, subcontractors), and entered into the project file.

All RI/FS/closure plan reports and supporting documents will be categorized as either primary or secondary documents. The process for document review and comment and maintenance of administrative records is covered by the *Tri-Party Agreement Action Plan* (Ecology et al. 1996).

7.2.6 Quality Assurance

The specific planning documents required to support the RI/FS/closure plans have been developed within the overall QA program structure mandated by the DOE for all activities at the Hanford Site. Within that structure, the documents are designed to meet current EPA guidelines for format and content and are supported and implemented through the use of standard operating procedures drawn from the existing program or that have been developed specifically for environmental investigations. In addition, there are other QA documents and guidelines that can be consulted and referred to that outline requirements defined by Ecology that must also be considered. To ensure that the objectives of this project are met in a manner consistent with applicable DOE guidelines, all work conducted by BHI will be performed in compliance with the BHI *ERC Quality Program* (BHI-QA-1) that specifically describes the application of manual requirements to environmental investigations. The QAPjP provided in Appendix A supports the overall approach described in this chapter. The QAPjP defines the specific means that will be used to help ensure that the sampling and analytical data are defensible and will effectively support the purposes of the investigation. The QAPjP will be implemented by this subtask. Details that are specific to each waste group being investigated will be documented in a QAPjP section of the group-specific work plans that will be reviewed and approved by the lead regulatory agency for the group-specific work plan.

7.2.7 Health and Safety

The health and safety plan (HASP) (Appendix B) will be used to implement standard health and safety procedures for BHI employees and contractors engaged in RI/FS activities in the 200 Areas. More specific details on the management aspects of the HASP are found in the appendix. A site-specific HASP will be written for each work plan or field activity as necessary and as determined by the Health and Safety officer in charge of the project. Minor activities that do not require the level of detail found in the HASP will be covered by an Activities Hazard Analysis.

7.2.8 Community Relations

Community relations activities will be conducted in accordance with the *Community Relations Plan for the Hanford Federal Site Facility Agreement and Consent Order* (Ecology et al. 1997). All community relations activities associated with the 200 Areas will be conducted under this overall Hanford Site Community Relations Plan.

7.3 INTERFACE WITH OTHER PROGRAMS AND AGENCIES

Several ongoing Hanford Site programs may impact or be impacted by ER (EM-40) activities. These programs include waste management (EM-30), Tank Waste Remediation System (EM-30), Facility Transition and Management (EM-60), and Technology Development (EM-50) programs. Several projects also exist in the ER Project that are active in the 200 Areas and require integration. The following sections provide a brief discussion of each project and identify mechanisms that are currently in place to integrate the projects.

The parties managing and overseeing characterization of the 200 Areas (ERC, the DOE, and regulatory agencies) interface with other programs through their involvement in, or oversight of, other Hanford Site programs, projects, or work groups, such as the following:

- Groundwater/Vadose Zone Integration Project
- D&D Strategy Work Group
- Facility transition supporting Tri-Party Agreement Amendment
- Canyon Initiative Team
- B Plant Transition
- RCRA Closures and Permitting
- Groundwater Remediation
- Tank Waste Remediation System
- 100 and 300 Area Remediation Projects
- Environmental Restoration Disposal Facility
- Low-Level Burial Grounds.

7.3.1 Groundwater/Vadose Zone Integration Project

As shown in Figure 7-2, there are numerous Hanford Site major projects working to solve contamination issues on the Site. The recent formation of the Groundwater/Vadose Zone (GW/VZ) Integration Project will be a key driver for insuring integration of GW/VZ activities in the 200 Areas. In addition to the *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities* (DOE-RL 1998a) the GW/VZ Project has several other key documents that define their project. The *Groundwater/Vadose*

Zone Integration Project Specification (DOE-RL 1998b), defines and communicates the vision, mission, goals, objectives, and technical boundaries for the scope of work needed to achieve the GW/VZ project objectives. The Groundwater/Vadose Zone Integration Project - Project Management Plan will define the overall management of the technical scope, cost, and schedule baselines for the GW/VZ Project and also will define the authorities, organizational roles, and responsibilities of the GW/VZ Project participants. An GW/VZ Project Baseline report will also be prepared that will identify the processes, tools, and resources required to develop and maintain the GW/VZ Project cost, schedule, and technical scope of work. It will also include the prioritization logic, the long range plan, and the detailed work plan of activities. Integration of 200 Area remedial action project activities with this team, through the review and concurrence on ER project detailed work plans by the GW/VZ Project Team, will be necessary as development of the group-specific work plans proceed.

As stated in the *Groundwater/Vadose Zone Integration Project Specification* (DOE-RL 1998b), "Integration is the heart of the GW/VZ integration project." Furthermore the "Integration Project seeks to remedy the fragmentation inherent in past approaches to characterization and assessment of impacts regarding contamination at, or originating from, the Hanford Site. The general approach is to (a) identify organization overlaps and other inefficiencies; (b) identify deficiencies in knowledge and the work needed to fill those deficiencies; and (c) using information from (a) and (b) to expeditiously implement appropriate remedies."

The Groundwater/Vadose Zone Integration Project also has the lead for working with the authors of the *Screening Assessment and Requirements for a Comprehensive Assessment, Columbia River Comprehensive Impact Assessment* (CRCIA) (DOE-RL 1998c). The CRCIA report was prepared by stakeholders to delineate requirements believed to be critical and that should be considered for long term assessment of the impacts of Hanford operations on the environment and public health. The GW/VZ project is reviewing the CRCIA requirements and working with CRCIA team representatives to understand the requirements. It is anticipated that the *Groundwater/Vadose Zone Integration Project Specification,* Appendix E *(DOE-RL* 1998b) will contain the guidelines or project-specific translation of how the CRCIA requirements will be implemented.

7.3.2 Environmental Restoration Project

The ER Project must assess and remediate inactive hazardous and radioactive facilities and waste sites, including past practice and RCRA TSD units. The ER project consists of several projects, including Remedial Actions and Waste Disposal, Groundwater Remediation, N Area, and D&D Projects.

Integration needs have been identified at various levels within the ER project. Several operable units have completed various levels of assessment work and include the 200-BP-1, 200-UP-2, and 200-ZP-2 source operable units, and the 200-UP-1, 200-ZP-1, 200-BP-5, and 200-PO-1 groundwater operable units. To date, the 200 Area source work has been based on the geographic operable unit approach to organizing waste sites. Sites within these source operable units were included in the groups established in the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997).

Interim groundwater remediation efforts are currently under way in the 200-UP-1 and 200-ZP-1 groundwater operable units and are being managed by the Groundwater Remediation Project. Integrating source (i.e., waste sites and associated vadose zone contamination) and groundwater projects will primarily be required in the long term to implement final remedial decisions for the 200 Areas. However, a more immediate need for groundwater/source integration exists in the Z Plant area where extensive carbon tetrachloride contamination exists in the vadose zone and groundwater. The 200-ZP-2 vapor extraction expedited response action is currently limited to four cribs. However, an expanded treatment program may be needed to address other areas of carbon tetrachloride contamination in the vadose zone in the 200 West Area. As group-specific work plans are developed, integration with the groundwater project will facilitate development of contaminants of concern that may be impacting groundwater from source sites. For work plans that include TSD units, closure and post closure groundwater monitoring activities will be prepared by the ER groundwater project and coordinated with the 200 Area soil assessment project. This will then insure integration with the overall groundwater/vadose zone project. Integration at this level will also serve to enhance coordination of the 200 Area group-specific work plans with other Hanford Site projects.

Integration with D&D projects occurs at three levels. One level is provided by the Radiation Area Remedial Action (RARA) program, which performs surveillance and maintenance at selected waste sites and interim stabilization of select inactive waste sites, if required. An annual report supplies information on the past years' surveillance and maintenance activities. Interim stabilization that may be required at a particular waste site is planned to include project input to ensure that the activity is consistent with possible CERCLA remedial actions. The information in the annual report is used to update WIDS to ensure that current status on waste sites is available. The second level of integration occurs during the facility transition process where the 200 Area project manager is involved in the review and acceptance of waste sites associated with the facility. The third level occurs when the long-range plan is updated yearly and the planned CERCLA and D&D activities are reviewed for possible impacts. In addition, there has been cross-project participation in strategy workshops, such as the current/ongoing canyon facility initiative team that looked at alternatives for D&D of the canyon facilities.

7.3.3 Other Hanford Site Programs

The waste management program manages waste generated on the Hanford Site, including the storage, treatment, and processing of defense high-level radioactive waste, waste minimization efforts, and corrective actions at waste management facilities. Numerous subprograms within waste management exist on the Hanford Site, including Tank Waste Remediation System (DOE 1996b), Solid Waste Management, Liquid Effluent, Spent Nuclear Fuels, and Analytical Services. Meetings with other waste management programs will be facilitated through the Groundwater/Vadose Zone Integration Project to provide the level of integration that is required.

The Facility Transition and Management Program must ensure that shutdown facilities are brought to a deactivated state, maintained, and eventually decontaminated and/or decommissioned or released for other uses. The Landord Program is a Site Infrastructure Division Program that is responsible for management of systems such as water, sewer, electricity, and communications on the Hanford Site.

The DOE Office of Technology Development must develop technologies to meet DOE's ER goals and work closely with other ER projects to identify, develop, and implement innovative technologies. The DOE Office of Technology Development has established five focus areas to address DOE's most pressing technology development needs, including (1) contaminant plume containment and remediation; (2) mixed waste characterization, treatment, and disposal; (3) high-level waste tank remediation; (4) landfill stabilization; and (5) D&D. Because of the unique nature of waste contamination and the lack of proven and cost-effective technologies, the need to evaluate promising technologies is recognized as an essential step to remediate the 200 Areas. The ER Project continues to actively work with the DOE Office of Technology Development to identify promising technologies and acquire the necessary support to evaluate/implement those technologies.

The Hanford Site Integrated Schedule identifies Hanford Site programmatic interfaces and site critical paths providing a high-level integrated plan. The Hanford Site Integrated Schedule provides a forum for dissemination of high-level summary schedule information between the various site programs, the stakeholders, and regulatory bodies. It provides a mechanism to integrate, analyze, and monitor Hanford Site programs.

7.3.4 Other Organizations

In addition to these other programs operating at the Hanford Site, there are a number of organizations that participate in providing recommendations that can affect the path the ER project follows. These organizations include the Hanford Advisory Board, the Interagency Management Integration Team, the Washington State Department of Health, Native American Indian Tribes, and other interested stakeholders.

7.4 SCHEDULE

Figure 7-3 provides a schedule that shows the 200 Areas Implementation Plan, milestone dates for the first six group-specific work plans that were identified in the *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997), and the remaining 17 work plans. This is based on Tri-Party Agreement change packages M-13-97-01 and M-20-97-01 approved in March 1998 to support the approach for the 200 Areas and to redefine existing milestones.

The implementation of this approach for the 200 Areas is driven by the requirement to meet the year 2008 Tri-Party Agreement milestone for completion of characterization activities. The schedule indicates that this milestone can be met with this approach.

As the first six group-specific work plans are being developed, the responsible regulatory agencies will meet to define the specific waste site groups that will be worked next. Experience gained during the investigation process for the first six groups will be used to refine characterization needs, establish priorities within the remaining work plans, and re-evaluate existing milestones or assign new milestones as needed. As work plans are written and characterization activities are initiated, the process will follow the integrated approach shown earlier in Figure 2-2 of this report. These investigations will be sufficiently comprehensive to satisfy the technical requirements of both RCRA and CERCLA programs when both past practice sites and TSD units are found in a waste site group. Each of the group-specific work plans will also contain enforceable schedules and milestones, consistent with Figure 2-2.

The schedule (Figure 7-3) assumes that the implementation plan and 23 work plans will be prepared; however, the number of work plans ultimately required will be based on the waste site groups and experience and information that is obtained as the process is followed. For planning purposes, 23 characterization activities, remedial investigation reports, and feasibility studies are assumed, consistent with the number of work plans. However, based on past experience in the 100 and 300 Areas, it is expected that additional consolidation of documents will occur as opportunities for additional streamlining are realized. With this same reasoning it may not be necessary to complete 23 proposed plans and RODs. Rather, it is reasonable to assume that streamlining of the decision-making process will be achieved that will allow consolidation of proposed plans and RODs, along with the use of explanation of significant differences and focus packages. Any modifications that occur, such as the reduction of the number of work plans or consolidation of documents, require regulator approval.

7.5 PUBLIC INVOLVEMENT

Public involvement is an integral and necessary part of DOE activities on the Hanford Site to ensure that decisions are made with the benefit and consideration of important public perspectives. This creates a mechanism that brings a broad range of diverse viewpoints and values into the DOE decision-making process, which enables DOE to make more informed decisions, improve quality through collaborative efforts, and build mutual understanding and trust between the DOE and the public.

Public involvement includes open, ongoing, two-way communication, both formal and informal, between DOE and its stakeholders, the regulators, and Tribal governments. It is intended as a means of keeping the public informed of progress and/or to status ongoing activities and/or issues. Public involvement is a process designed to increase opportunities for the public and the DOE to obtain the best information possible upon which to make informed decisions.

Tribal governments have a unique legal relationship with the U.S. government as set forth in the Constitution of the United States, treaties, statutes, and court decisions. The United States has committed to a government-to-government relationship with Indian tribes. Rather that seeking tribal participation through public forums, the DOE consults directly with Tribal Governments prior to taking actions that may affect their rights and interests, as outlined in the DOE American Indian Policy. The goals, core values, and principles of this public involvement policy apply equally to stakeholders and affected Tribes alike.

Within the 200 Areas project, opportunities for public involvement will occur as the process of characterization and remediation continues. Specific areas of public involvement are discussed further in Section 2.3 and are shown in Figure 2-2. The general public will be initially involved via this Implementation Plan and several of the initial group-specific work plans. Following completion of these reviews, it will be determined if future work plans need to be provided for public review. Other documents where public comment opportunities exist include proposed plans, proposed permit modifications, and remedial design and remedial action work plans.

Public participation opportunities are available through a number of organizations such as those discussed in Section 7.3.3. In addition, the Community Relations Plan (Ecology et al. 1997) specifies how the public can be involved in the processes that are followed on the Hanford Site. This is discussed further in Section 10 of the *Tri-Party Agreement Action Plan* (Ecology et al. 1996).

Figure 7-1. Project Organization for the 200 Areas RI/FS and Closure Plan Activities.

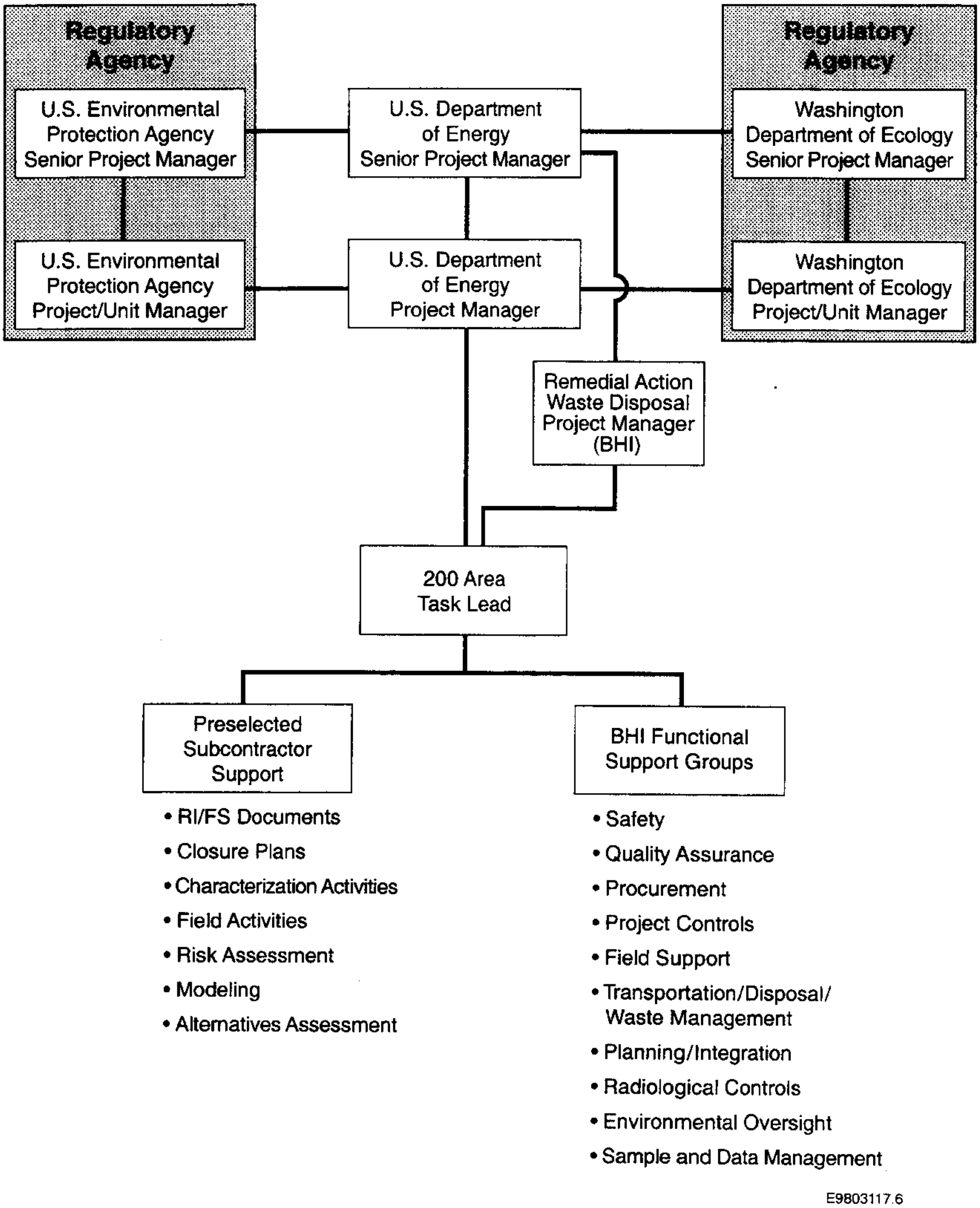
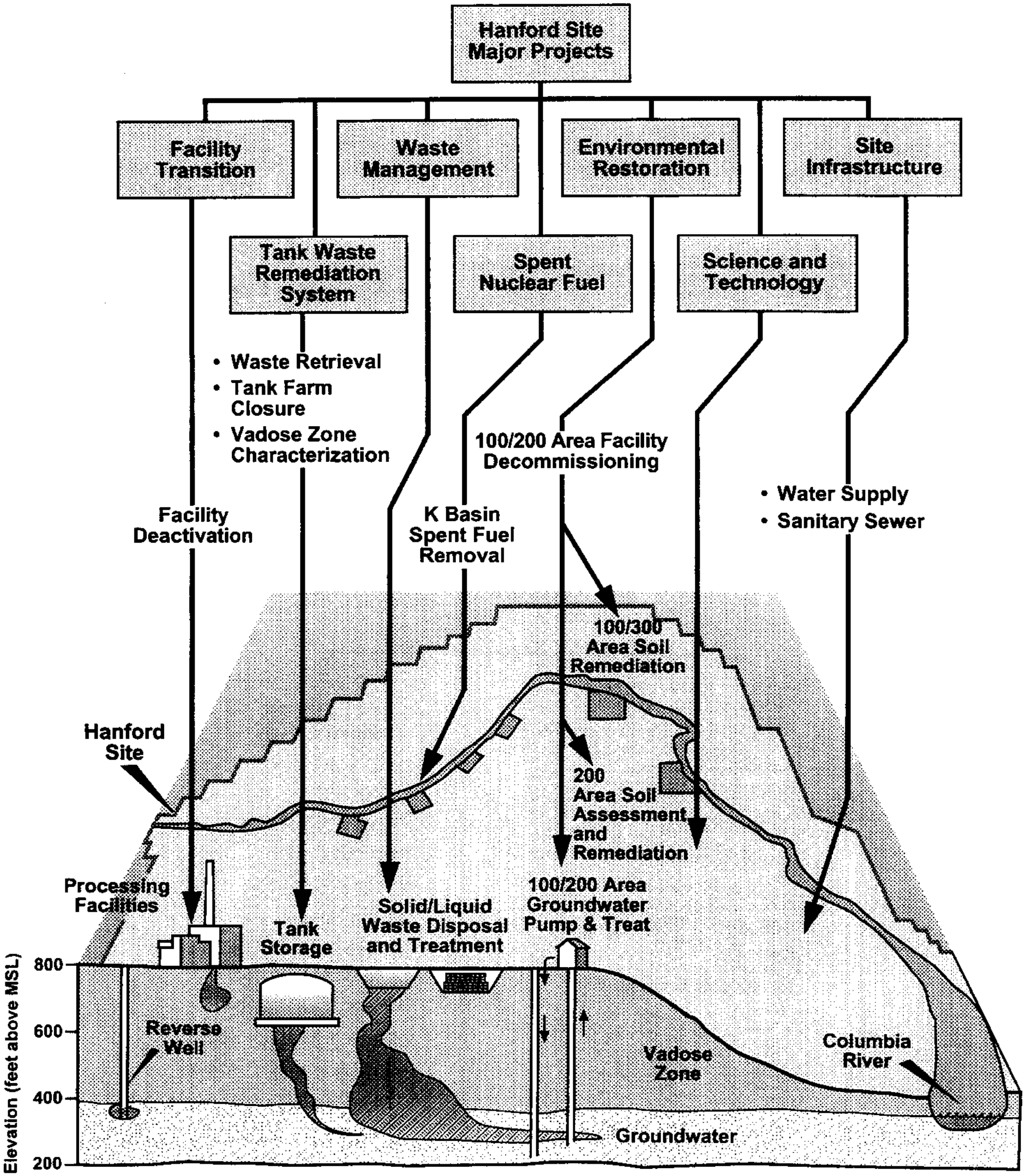


Figure 7-2. Current Groundwater/Vadose Zone Project-Related Activities.



(Amended from DOE/RL-98-03)

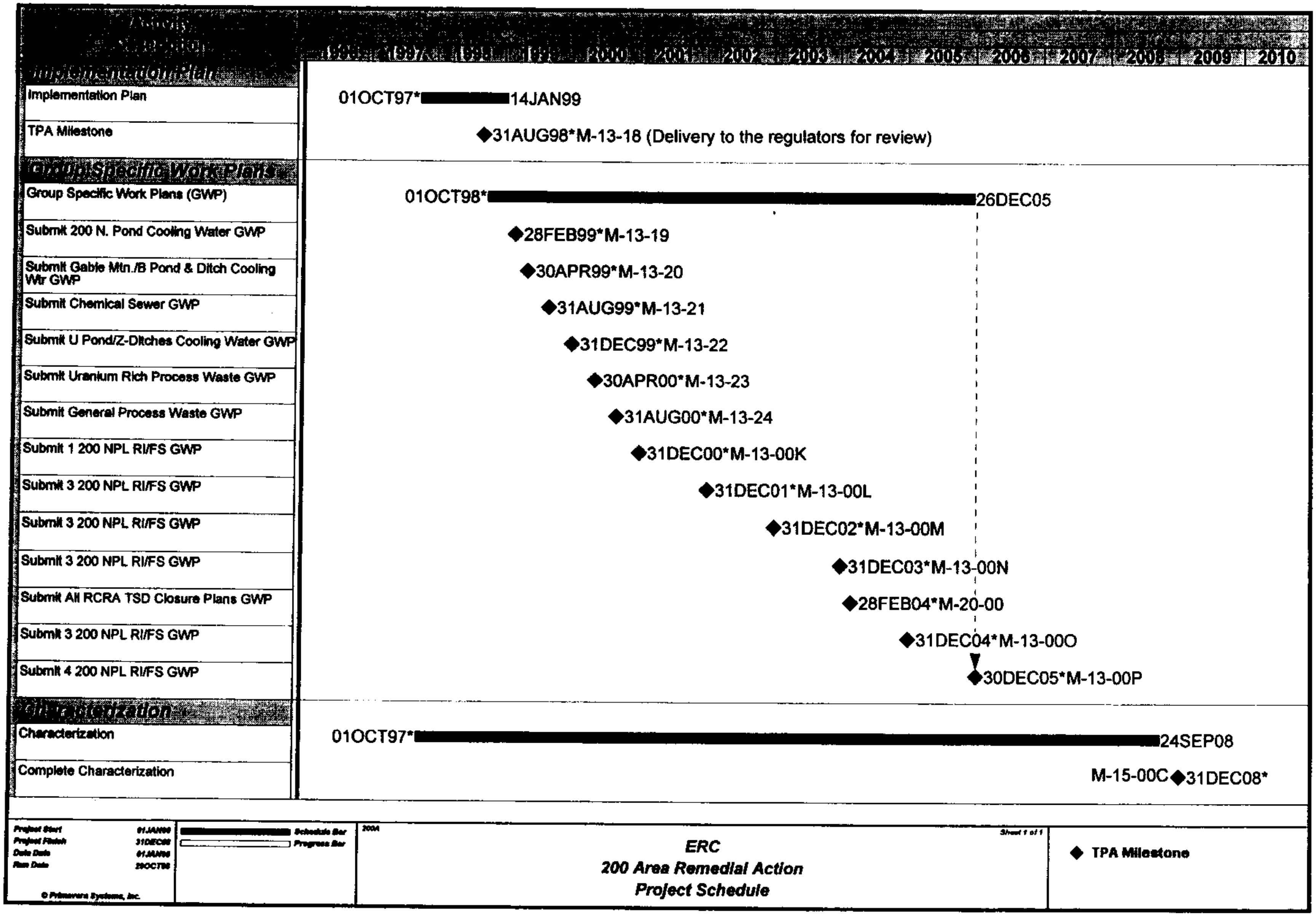


Figure 7-3. 200 Areas Soil Strategy Conceptual Schedule.

8.0 REFERENCES

APHA, AWA and WEF, 1992, *Standard Methods for the Examination of Water and Wastewater*, 18th Edition, American Public Health Association and American Waterworks Association, and Water Environmental Federation.

Archeological and Historic Preservation Act, 16 U.S.C. 469 et seq.

40 CFR 20, "Certification of Facilities," *Code of Federal Regulations*, as amended.

40 CFR 196, "Radiation Site Cleanup Regulation," *Code of Federal Regulations*, draft.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Units," *Code of Federal Regulations*, as amended.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

40 CFR 270, "EPA Administered Permit Programs: The Hazardous Waste Permit Program," *Code of Federal Regulations*, as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, as amended.

BHI, 1995a, *B Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00179, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1995b, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00178, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1995c, *S Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00176, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1995d, *T Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00177, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1995e, *U Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00174, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1995f, *Z Plant Aggregate Area Management Study Technical Baseline Report*, BHI-00175, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998, *Remedial Action and Waste Disposal Project Manager's Implementing Instructions*, BHI-00901, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigation Instructions*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-01, *ERC Quality Program*, Bechtel Hanford, Inc., Richland, Washington.

Clean Water Act of 1977, *33 U.S.C. 1251, et seq.*

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601 et seq.

CRC, 1980, *Chemical Rubber Company Handbook of Chemistry and Physics*, R. C. Weast and M. J. Astle (eds.), 61st edition, CRC Press, Inc., Boca Raton, Florida, pp. B-44-45.

DeFord, D. H., 1991, 200 North Aggregate Area Management Study, Technical Baseline Report, WHC-SD-EN-ES-020, Westinghouse Hanford Company, Richland, Washington.

DeFord, D. H., 1992, Semiworks Aggregate Area Management Study, Technical Baseline Report, WHC-SD-EN-ES-019, Westinghouse Hanford Company, Richland, Washington.

DOE, 1996a, Draft *Hanford Remedial Action – Environmental Impact Statement, and Comprehensive Land Use Plan,* DOE/EIS-0222D, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE, 1996b, *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, U.S. Department of Energy, Washington D.C.

DOE, 1998, Revised Draft *Hanford Remedial Action – Environmental Impact Statement, and Comprehensive Land Use Plan,* DOE/EIS-0222D, U.S. Department of Energy, Washington D.C.

DOE Order 4700.1A, "Project Management System," U.S. Department of Energy, Washington, D.C.

DOE Order 5480.21, "Unreviewed Safety Questions," U.S. Department of Energy, Washington, D.C.

DOE Order 5480.22, "Technical Safety Requirements," U.S. Department of Energy, Washington, D.C.

DOE Order 5480.23, "Nuclear Safety Analysis Reports," U.S. Department of Energy, Washington, D.C.

DOE Order 5481.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," U.S. Department of Energy, Washington, D.C.

DOE-RL, 1989, *Environmental Restoration Field Office Management Plan*, DOE/RL-89-29, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook*, RL-TPA-90-0001, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1991, *Hanford Past Practice Strategy*, DOE/RL-91-40, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1992a, *S Plant Source Aggregate Area Management Study Report*, DOE/RL-91-60, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1992b, *T Plant Source Aggregate Area Management Study Report*, DOE/RL-91-61, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington

DOE-RL, 1992c, *U Plant Source Aggregate Area Management Study Report*, DOE/RL-91-52, Rev. 0, U.S. Department of Energy, Richland Operations, Office, Richland, Washington.

DOE-RL, 1992d, *Z Plant Source Aggregate Area Management Study Report*, DOE/RL-91-58, Rev. 0, U.S. Department of Energy, Richland Field Operations, Richland, Washington.

DOE-RL, 1993a, *200 East Groundwater Aggregate Area Management Study Report*, DOE/RL-92-19, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993b, *200 North Aggregate Area Source Aggregate Area Management Study Report*, DOE/RL-92-17, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993c, *200 West Groundwater Aggregate Area Management Study Report*, DOE/RL-92-16, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993d, *B Plant Source Aggregate Area Management Study Report*, DOE/RL-92-05, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993e, *Hanford Facility Dangerous Waste Part A Permit Application*, DOE/RL-88-21, Vols. 1-3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993f, *PUREX Source Aggregate Area Management Study Report*, DOE/RL-92-04, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993g, *Semiworks Source Aggregate Area Management Study Report*, DOE/RL-92-18, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1995, *Hanford Sitewide Ground Water Remediation Strategy*, DOE/RL-94-95, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1996a, *200 Areas Soil Remediation Strategy – Environmental Restoration Program*, DOE/RL-96-67, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1996b, *Draft Hanford Mission Direction Document*, DOE/RL-96-14, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1997, *Waste Site Grouping for 200 Areas Soil Investigations*, DOE/RL-96-81, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998a, *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities*, DOE/RL-98-03, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998b, *Groundwater/Vadose Zone Integration Project Specification*, DOE/RL-98-48. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998c, *Screening Assessment and Requirements for a Comprehensive Assessment, Columbia River Comprehensive Impact Assessment*, DOE/RL-96-16, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1991, *Hanford Federal Facility Agreement and Consent Order, Change Package*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, Fourth Amendment, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1996, *Tri-Party Agreement Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1997, *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA, 1979, *Methods for Chemical Analysis of Water and Wastes,* EPA-600/4-79-020, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

EPA, 1986, *Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods, SW-846,* 3rd Edition, Nov. 1986, et seq U.S. Environmental Protection Agency, Washington D.C.

EPA, 1988, *CERCLA Compliance with Other Laws Manual, Interim Final*, EPA/540/G-89/006, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1989a, *CERCLA Compliance with Other Laws Manual: Part II, Clean Air Act and Other Environmental Statutes and State Requirements*, EPA/540/G-89/009, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1989b, *Risk Assessment Guidance For Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final*, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1993, *The Data Quality Objectives Process for Superfund Interim Final Guidance*, EPA/540/R-93/071, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA 1997a, *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, EPA OSWER Direction No. 9200.4-18, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1997b, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites,* EPA OSWER Direction No. 9200.4-17, U.S. Environmental Protection Agency, Washington, D.C.

EPA, Ecology, and DOE, 1995, *Record of Decision for the Environmental Restoration Disposal Facility*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

EPA, Ecology, and DOE, 1996, *U.S. Department of Energy Environmental Restoration Disposal Facility – Hanford Site Benton County, Washington – Explanation of Significant Difference*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

ER-PC-01, *Baseline and Funds Management System*, Bechtel Hanford, Inc., Richland, Washington.

Fecht, K. R., G. V. Last, and K. R. Price, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells*, ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

GE, 1945, *Hanford Technical Manual*, HW-10475C, General Electric Company, Hanford Works, Richland, Washington.

GE, 1950, *An Introduction to the TBP and UO3 Plants*, HW-19400, General Electric Company, Hanford Works, Richland, Washington.

GE, 1951a, *Hot Semiworks Manual*, Part 1, HW-22955, General Electric Company, Hanford Works, Richland, Washington.

GE, 1951b, *PUREX Technical Manual*, HW-31000, General Electric Company, Hanford Works, Richland, Washington.

GE, 1951c, *Uranium Recovery Manual*, HW-19140, General Electric Company, Hanford Works, Richland, Washington.

GE, 1951d, *REDOX Technical Manual*, HW-18700, General Electric Company, Richland, Washington.

Gustavson, O. R., 1950, *An Introduction to the TBP and UO3 Plants*, HW-19400, General Electric Company, Hanford Atomic Production Operations, Richland, Washington.

Hartman, M. J. and P. E. Dresel, 1998, editors, *Hanford Site Groundwater Monitoring for Fiscal Year 1997*, PNNL-11793, Pacific Northwest National Laboratory, Richland, Washington.

ICRP, 1991, *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Annals of the ICRP Vol. 21, International Commission on Radiological Protection.

Isochem, 1967, *Waste Management Technical Manual*, J. S. Buckingham, ed., Isochem, Inc., Richland, Washington.

Johnson, V. G., 1993, *Groundwater Impact Assessment Report for the 216-Z-20 Crib, 200 West Area*, WHC-EP-0674, Westinghouse Hanford Company, Richland, Washington.

Johnson, V. G., A. G. Law, S. P. Reidel, S. D. Evelo, D. B. Barnett, and M. D. Sweeney, 1993, Groundwater Impact Assessment Report for the 216-B-3 Pond, WHC-EP-0813, Westinghouse Hanford Company, Richland, Washington.

Johnson, V. G., D. L. Graham, and S. P. Reidel, 1993, "Methane in Columbia River Basalt Aquifers: Isotopic and Geohydrologic Evidence for a Deep Coal-Bed Gas Source in the Columbia Basin, Washington," *American Association of Petroleum Geologists Bull*, V. 77, No. 7, pp. 1192-1207.

Kaplan, D. J., R. J. Serne, and M. G. Peipho, 1995, Geochemical Factors Affecting Radionuclide Transport *Through Near and Far Fields at a Low-Level Waste Disposal Site,* PNL-10379, Pacific Northwest National Laboratory, Richland, Washington.

Narbutovskih, S. M., R. K. Price, and V. J. Rohay, 1997, "Vadose-Zone Contamination," Section 4 in *Hanford Site Groundwater Monitoring for Fiscal Year 1996,* M. J. Hartman and P. E. Dresel, eds., PNNL-11470, Pacific Northwest National Laboratory, Richland Washington.

National Historic Preservation Act of 1966, 16 U.S.C. 470, et seq.

NCRP, 1987, *Recommendations on Limits for Exposure to Ionizing Radiation,* NCRP Report No. 91, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Neitzel, D. A. (editor), 1997, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415, Rev. 9, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

RHO, 1983, *PUREX Technical Manual*, RHO-MA-116, Rockwell Hanford Operations, Richland, Washington.

Roblyer, S. P., 1997, "Radionuclides in the 105-C Fuel Transfer Pits," letter, to C. A. Palmquist, May 14, 1997.

Safe Drinking Water Act of 1974, 42 U.S.C. 300f, et seq.

Serne, R. J. and M. I. Wood, 1990, *Hanford Waste-Form Release and Sediment Interaction,* PNL-7297, Pacific Northwest Laboratory, Richland, Washington.

Stephens, Daniel B., 1996, *Vadose Zone Hydrogeology*, Lewis Publishers, CRC Press, Boca Raton, Florida.

Super Fund Amendments and Reauthorization Act of 1986, 42 U.S.C. 9601, et seq.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-340, "Model Toxics Control Act - Cleanup," *Washington Administrative Code*, as amended.

Walker, F. W. J. R. Parringon, and F. Fenier, 1989, *Nuclides and Isotopes*, 14th ed., General Electric Company, San Jose, California.

Washington Hazardous Waste Management Act of 1976, as amended.

WHC, 1991, *Historical Perspective of Radioactively Contaminated Liquid and Solid Wastes Discharged or Buried in the Ground at Hanford*, TRAC-0151-VA, Westinghouse Hanford Company, Richland, Washington.

Zimmerman, D. A., A. E. Reisnauer, G. D. Black, and M. A. Young, 1986, *Hanford Site Water Table Changes* 1950 through 1980, *Data Observations and Evaluation*, PNL-5506, Pacific Northwest Laboratory, Richland, Washington

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

A1.0 INTRODUCTION

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling and analysis, performed in support of 200 Area activities. This plan complies with the requirements of U.S. Department of Energy (DOE) Order 5700.6C, *Quality Assurance*; 10 *Code of Federal Regulations* (CFR) 830.120, "Quality Assurance Requirements;" the *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994); and the *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) (DOE-RL 1998). The plan is supplemented by environmental investigation procedures (EIPs) in BHI-EE-01, *Environmental Investigations Procedures*, which document sampling practices, and Environmental Restoration Contractor (ERC) sample and data management quality assurance program plans provided in BHI-QA-03, *ERC Quality Assurance Program Plans*.

The purpose of this appendix is to provide a framework of general requirements that apply to each of the 23 waste site groups covered in the *200 Areas RI/FS Implementation Plan*. The general requirements identified in this appendix shall be supplemented by specific waste site group requirements developed through the data quality objectives (DQO) process and documented in the associated group-specific work plans, sampling and analysis instructions, sampling and analysis plans (SAPs), and characterization plans. By following and referencing the guidelines in this appendix the group-specific sampling documents should not require individual QAPjPs, thus streamlining the sampling process.

A2.0 PROJECT MANAGEMENT

This section addresses the basic areas of project management and ensures that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planned outputs have been appropriately documented. Also included in this section is a discussion of the quality objectives and background information on the sampling and analysis strategy for assessment of the 200 Areas.

A2.1 PROJECT/TASK ORGANIZATION

The 200 Areas project shall be managed through the ERC Remedial Action and Waste Disposal (RAWD) Project on behalf of the DOE. The principles and responsibilities discussed in the *Remedial Action and Waste Disposal Project Manager's Implementing Instructions* (BHI 1998) are hereby incorporated into this document. All personnel assigned to the RAWD Project must comply with these Project Manager's Implementing Instructions. General positions and responsibilities for the project manager and task lead have been described in Section 7.2. Other support staff (functional group or preselected subcontractor) will be identified by the task lead to accommodate the needs of the project (i.e., remedial investigation/feasibility study [RI/FS] characterization or assessment activities require different staffing than do remedial action activities).

Specific personnel assignments shall be documented in the group-specific work plan for each waste site grouping. Some of these staff may include the following:

- **Project Engineer**. The project engineer reports to the task lead and is responsible for the design engineering and for providing technical assistance to field support and health and safety programs. The project engineer ensures the technical adequacy of the scope of work, including sampling and analysis activities.

- **Field Superintendent**. The field superintendent reports to the task lead and has the ultimate responsibility for everything that occurs at the site. The field superintendent provides equipment resources and is responsible for direction of craft personnel for execution of the work scope. Other duties include maintenance of the site logbook.

- **Health and Safety**. The health and safety officer is matrixed to the task lead and provides health and safety planning and oversight to the project. The health and safety officer is responsible for reviewing the generic health and safety plan (Appendix B) and identifying/documenting any waste grouping-specific health and safety needs for the project. The health and safety officer routinely provides input to the field superintendent to ensure safe execution of the project operations. The health and safety officer is responsible for monitoring all potential health and safety hazards during field activities, including those associated with radioactive and hazardous materials. The health and safety officer has the responsibility and authority to halt field activities resulting from unacceptable health and safety hazards.

- **Waste Management**. The waste management representative is matrixed to the field superintendent and is responsible for preparation of site-specific waste management instructions in accordance with BHI-EE-10, *Waste Management Plan*. Other duties include waste profile evaluation, waste packaging, and waste shipment.

- **Environmental Lead**. The environmental lead is matrixed to the task lead and ensures that all environmental requirements are addressed in accordance with appropriate laws, regulations, policies, procedures, practices, environmental design criteria, permits, and DOE directives.

- **Sampling and Characterization**. The organization responsible for sampling and characterization provides functional support personnel as needed for sample collection, onsite measurements, sample shipping, sample tracking, and data management. This organization is also responsible for management and coordination of communication with contract laboratories. Other duties include development and maintenance of any project-specific database applications that are needed by the project.

- **Radiological Controls**. The radiological control group is responsible for radiological control technician coverage for the project. Other duties include preparing Radiological Work Permit (RWP) documentation and overseeing work performed in controlled areas under an RWP.

- **Quality Assurance Representative**. The quality assurance (QA) representative is matrixed to the task lead and is responsible for project QA issues, and coordination/performance of self-assessment, surveillance, and audit activities. Other duties include support to identification and implementation of corrective actions and communication of lessons learned information from other projects. This designated person shall have the necessary independence and authority to identify conditions adverse to quality and to systematically seek corrective action.

A2.2 PROBLEM DEFINITION/BACKGROUND

The *200 Areas RI/FS Implementation Plan* provides a framework for implementing assessment activities to ensure consistency in documentation, level of characterization, and decision making for the 200 Area waste sites. The Implementation Plan uses an analogous site concept in which waste sites are organized into waste groups based on similar processes, waste disposal histories, and type of site. Within these groups, representative sites have been identified for initial characterization to refine the contaminant distribution conceptual model and support remedy selection for the waste group.

Data collection at these representative sites will be guided by the waste group-specific DQO, and will typically utilize biased sampling to target the areas that are likely to have some of the higher levels of contamination. These data should be of sufficient quality and quantity to support the selection of the most appropriate remedy with an acceptable degree of confidence and should be suitable as a basis for a quantitative risk assessment.

In addition to the initial characterization of representative waste sites, two other principal types of data will be collected: confirmation data and verification data.

Confirmation data will be used to decide if the selected remedy is appropriate for all waste sites in a waste group. These data will also be used for remedial design at individual waste sites. These data should be of necessary quality and quantity to make informed decisions regarding the suitability of a chosen remedial alternative.

Verification data will be used to demonstrate the effectiveness of the remedy at each waste site after completion of the remedial action(s). These data should be of the necessary quality and quantity to support the remedial alternative decision. For example, sites that were remediated by remove, treat, and dispose options should have data that show that the remedial action objectives (RAOs) have been achieved.

A more detailed explanation of these three types of characterization data is given in Section 6.2 of the Implementation Plan.

In addition to the characterization data, certain remedial options will generate a large amount of data in the field during the course of remediation. For example, liquid waste sites that are remediated with a remove, treat, and dispose option will use the observational approach, which relies on field instruments to measure radionuclide activity in a waste site during excavation to determine when enough contaminated material has been removed to satisfy the RAOs. This approach, which has been successfully demonstrated in the 100 Area, is based on the assumption that the radionuclide(s) being measured are associated with all the contaminants of concern, including nonradioactive chemicals. Field data of this type should be of sufficient quality and quantity to guide the necessary field decisions (e.g., continue or terminate excavation, comply with waste disposal criteria).

A2.3 PROJECT/TASK DESCRIPTION

The tasks associated with the various phases of work in the 200 Areas include the different types of characterization sampling discussed in Section A2.2, as well as tasks related to delineation of waste site boundaries and field monitoring associated with cleanup using the observational approach. A list of potential tasks is presented in Table A-1. This list is intended to be used during the waste group-specific DQO to assist in choosing appropriate tasks, and in the group-specific sampling documents.

A2.4 PROJECT QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT PERFORMANCE DATA

Specific data quality requirements shall be developed for each waste site grouping for each phase of characterization through the DQO process as specified in BHI-EE-01, *Environmental Investigations Procedures*, Section 1.2, "Data Quality Objectives." A list of items that should be covered during the typical DQO process is presented in Table A-2.

The results of the DQO process shall be reflected within the document structure of the group-specific work plan and/or sampling document as a summary table of data quality requirements. Suggested elements of the summary table include references to the measurement parameter (e.g., analyte), required action level, and required precision and accuracy criteria for each type of sample media (e.g., soil, water). Separate tables or references may be required to summarize the requirements for different types of data acquisition such as field screening and verification.

A.2.5 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Training or certification requirements for ERC personnel are described in BHI-HR-02, *ERC Training Procedures*. Specific training requirements for personnel supporting the data acquisition process are identified in BHI-QA-03, *ERC Quality Assurance Program Plans*, as listed and summarized below.

The "Field Sampling Quality Assurance Plan" (Plan 5.1) summarizes functional responsibilities, describes and depicts lines of authority, and lists the duties within the organization. The QA elements for ERC sampling activities that should be addressed in project documents used to conduct field sampling are also identified.

The "Onsite Measurements Quality Assurance Program Plan" (Plan 5.2) establishes the management policy applicable to onsite measurements personnel, identifies the QA responsibilities of personnel conducting onsite measurements for the ERC, defines the operating procedures and standard quality control (QC) processes used to conduct activities that meet customer quality specifications, and implements applicable sections of the HASQARD (DOE-RL 1998). This procedure applies to the inorganic and organic chemistry onsite measurement activities performed in support of ERC projects.

The "Radiological Measurements and Environmental Support Quality Assurance Program Plan" (Plan 5.3) provides the QA guidance, QA requirements, and QC specifications for onsite radiological measurements that generate data on environmental parameters in support of ERC projects. This procedure defines the operating procedures and standard QC processes for field radiological measurements and for the ERC Radiological Counting Facility.

Field personnel shall have completed Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker training and Hanford General Employee Training before starting work. Personnel transporting samples from the various 200 Area work sites to the designated Sample Storage Facility or to laboratories shall have completed U.S. Department of Transportation shippers training. Any waste site group-specific training requirements shall be specified in the appropriate group-specific sampling document.

A2.6 DOCUMENTATION AND RECORDS

Sample collection and analysis activities shall be planned in accordance with BHI-EE-01, Procedure 2.0, "Sample Event Coordination." The Sample Authorization Form/Field Sampling Requirements (SAF/FSR) information generated through the sample event coordination process shall document the following for onsite measurements and laboratory test methods:

- Test method/analyte and holding time
- Sample media
- Sample container type, size, and preservatives
- Turnaround times
- Data deliverable types.

Field documentation shall be maintained in accordance with BHI-EE-01, including the following procedures:

- Procedure 1.5, "Field Logbooks," establishes the methods that are to be used for obtaining, controlling, and dispositioning field logbooks and identifies requirements for using field logbooks. It requires that field logbook entries be made in a manner that provides a legally defensible record of work that has been performed. The procedure requires that, at a minimum, sufficient data and information should be recorded so that the information can be used in the future to refresh the memories of the participants and to enable the participants to reconstruct the activities that occurred. Erroneous information is not to be obliterated. The field logbooks, or any portions thereof, are not to be thrown away or destroyed even if they are damaged, illegible, or contain inaccuracies that require annotation. When the logbook is completed (upon project completion or when all pages of the logbook have been used), the entire original logbook is transmitted to the ERC Document and Information Services in accordance with the approved Records Inventory and Disposition Schedule.

- Procedure 1.13, "Environmental Site Identification and Information Reporting," establishes the method for reporting the existence of a potential environmental site or new or previously undocumented information about an established/documented waste site so that the site can be investigated. The resulting information will be placed in the Waste Information Data System.

- Procedure 3.0, "Chain of Custody," establishes methods for documenting and maintaining chain of custody (COC) for environmental samples. It lists the information required on the COC documentation (e.g., sample identification number(s), sample matrix, sample preservation used, requested analysis performed by the support service organization) and activities from sample generation through receipt by the analytical laboratory (e.g., signatures and printed names of all individuals involved in the transfer of sample custody). The procedure requires that the COC documentation remains with its related samples from the point of sample collection until the samples are received by the analytical laboratory.

Results of onsite measurement tests shall be managed in accordance with BHI-EE-05, *Field Screening Procedures*, Procedure 1.7, "Preparation, Review, and Control of Organic/Inorganic Data Packages." This procedure establishes guidance for preparation, content, review, and control of data deliverables to ensure consistent documentation of organic/inorganic onsite measurement data packages.

Data deliverables from the analytical laboratory shall be managed in accordance with BHI-EE-01, Section 2.0, "Sample Management," which establishes procedures from initiation of a sampling event through final disposition to Document and Information Services and the records holding area. Any waste site group-specific documentation requirements shall be specified in the appropriate group-specific work plan and/or sampling document.

A3.0 MEASUREMENT/DATA ACQUISITION

The following section presents the general requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory quality control. The requirements for instrument calibration and maintenance, supply inspections, data acquisition, and data management are also discussed.

A3.1 SAMPLING METHODS

The type, number, and location of samples will be determined in the waste site-specific DQO. Sampling methods will typically be based on the character of the soil (e.g., unconsolidated, cobbles), depth of sample, type of analyses (e.g., volatile compounds, metals, physical properties), and volume of material required. Table A-3 presents typical methods of soil sampling and some of their advantages and limitations. This table is intended to be used during the DQO process to assist in choosing the most appropriate technique to employ at the waste sites being considered.

Samples for the various 200 Areas waste site groupings shall be collected in accordance with procedures found in BHI-EE-01, which include the following:

- Procedure 4.0, "Soil and Sediment Sampling," which describes various methods for performing soil and sediment sampling for compliance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* and *Resource Conservation and Recovery Act of 1976* (RCRA) requirements. The procedure details the decontamination of sampling tools, proper packaging of a sample, and documentation of the sampling event.

- Procedure 4.4, "Container Sampling," describes how samples should be collected from containers, based on the physical characteristics of the sample (e.g., liquid, soil, sludge).

If any nonstandard sample collection is identified during the DQO, a procedure will be prepared and identified in the sampling document prior to sample collection.

A3.2 SAMPLE HANDLING AND CUSTODY

Sample handling, shipping, and custody shall be performed in accordance with BHI-EE-01, Procedure 3.1, "Sample Packaging and Shipping," Procedure 3.0, "Chain of Custody" (described in Section A2.6), and Procedure 4.2, "Sample Storage and Shipping Facility." These procedures detail the procedure and proper documentation for sample packaging, storage, and offsite shipping.

Procedure 3.1, "Sample Packaging and Shipping," establishes requirements for the packaging and shipment of samples. Because of the complexity of the regulations, it is not possible to cover all situations; therefore, this procedure is used in conjunction with the relevant regulations published by the U.S. Department of Transportation and the International Air Transport Association. The procedure also ensures that samples will be transported in a manner that protects the sample integrity.

Procedure 4.2, "Sample Storage and Shipping Facility," establishes the methods for maintaining custody of environmental samples before and during shipment to the analytical laboratory, including methods for maintaining sample integrity during temporary storage at the 3728 Sample Storage and Shipping Facility.

A3.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIME

The sample preservation, container, and holding time requirements for applicable test methods shall be specified in the SAF/FSR information as specified in Section A2.6 of this appendix. The requirements for the specific test/laboratory methods of each waste site grouping shall be presented in a summary table within the applicable group-specific work plan and/or sampling document.

A3.4 ANALYTICAL METHODS

The analytical methods necessary to achieve the appropriate quality of data will vary according to the quality objectives developed during the DQO for the different types of samples collected (e.g., characterization, verification). The general types of sampling data and associated levels of data quality are summarized in Section A2.2.

The specific waste site grouping analytical methods shall be presented in the group-specific work plan or sampling document as a summary table. Suggested elements of the summary table include references to the analytical method, measurement parameter (e.g., analyte), detection/quantitation limit, and precision and accuracy criteria. Separate tables or references may be required to summarize the requirements for different types of data acquisition, such as field screening and verification.

The following provides more detail on the type of analyses that should be implemented for the different types of samples and some guidelines on data quality. Specific analytical methods and associated data quality (e.g., detection limits) will be established in the waste group-specific DQO. Most of the required analyses are readily available through existing contracts with various laboratories. The need versus cost for analyses that are not included in an existing contract will be evaluated during a waste group-specific DQO.

A3.4.1 Initial Characterization Data

The initial characterization data should be of sufficient quality to adjust or verify the physical contaminant distribution model, support analysis of a remedy selection, and use for a quantitative risk assessment, if appropriate. The analytical methods shall have detection limit goals that are at least as low as the most restrictive cleanup values that could be considered. For nonradionuclides, these are dictated by *Model Toxics Control Act* (MTCA) cleanup values. Where these values are lower than standard detection limits (e.g., arsenic, beryllium) the cleanup value will equal the local Hanford Sitewide background concentration (DOE-RL 1995) or the limit of quantification if a background value is not available. For radioactive constituents, cleanup values are typically calculated using an exposure model which estimates the dose a person would receive in a specific land-use scenario.

It is reasonable to expect that some of the initial characterization samples will have very high concentrations of some chemicals and/or high activity. In these cases a low detection limit may be unobtainable for constituents present in lower concentrations due to interelement interferences or dilutions required for analytical accuracy. Samples that are highly contaminated may not yield data that meet all the preferred goals for characterization samples.

In order to support the decision documents that authorize the selected remedy, these data must be of high quality. The appropriate analytical methods for nonradionuclides should follow the procedures outlined in *Test Methods for Evaluating Solid Waste* (SW-846, EPA 1986). The requested documentation from the laboratory should be at least a summary report, which will support a level of validation that includes review of holding times, blank contamination, precision, and accuracy. There are no standard methods (e.g., SW-846) for radionuclide analysis, but common fixed laboratory techniques and practices produce adequately low detection limits and high quality control.

A3.4.2 Confirmation Data

The data collected to evaluate the appropriateness of the selected remedy for individual waste sites and assist in the remedial design process will vary with the needs of the project. The data needs will be developed in a waste group-specific DQO after completion of the initial characterization.

A3.4.3 Verification Data

Verification data will be used to evaluate if RAOs have been achieved at the individual waste sites and to support documentation relating to closeout/closure of sites. To satisfy these objectives, these data shall be of similar quality to the initial characterization data. Specific requirements will be developed in the waste group-specific DQO.

A3.4.4 Remedial Action Data

As discussed in Section A2.2, it is anticipated that, for certain remedial alternatives, a large amount of data will be generated in the field during the course of remediation. These data will typically utilize field instruments to guide remedial operations. The field instruments should yield data of high enough quality to support the remedial operation and verify waste profiles. The procedures in BHI-EE-05, *Field Screening Procedures*, define the operating procedures and standard QC processes used to conduct onsite measurement tests performed by the ERC, to provide results of known and consistent quality for project use. Information regarding the use of the data should be provided through the waste group-specific DQO process, along with information regarding the analytical method, detection levels, data assessment requirements, quality control levels, and data management requirements.

A3.5 QUALITY CONTROL

Quality control measures shall be followed in the field and laboratory to ensure that reliable data are obtained. When performing this field sampling effort, precaution shall be taken to prevent the cross-contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity. During the DQO process, specific waste site groups may require QC elements at a frequency other than those identified in this appendix. The applicable QC requirements shall be documented in the group-specific sampling plan.

A3.5.1 Field Quality Control

Several control samples are introduced into the collection system to monitor the adequacy of the sampling system and the integrity of samples during their journey from the field collection point through laboratory analysis. The frequency and type of QC samples to be collected are specified in the sampling document. The following sections define these samples, grouped according to their primary purpose.

A3.5.1.1 Field QC Samples for Sampling Evaluation.

- **Trip Blanks.** Trip blanks are used to detect possible contamination during sample shipping and handling. A trip blank is typically a sample container filled with distilled/deionized water that is transported to the sampling site and then submitted to the laboratory with the samples. Trip blanks are filled in the laboratory, or at the 3728 Sample Storage Facility, and are not to be opened in the field. The frequency of use of the trip blank should be specified in the site-specific SAP; generally, one trip blank per cooler or sample shipment is submitted to the laboratory. Each trip blank should be stored at the laboratory with associated samples and analyzed with those samples.

  Trip blanks are primarily used when samples are to be analyzed for volatile organic compounds. However, trip blanks may be used for any parameter when there is concern that concentration of the parameter is biased by contamination. A trip blank will not only detect contamination during the shipping and handling of the containers, but will also serve to detect contamination from containers (i.e., function as a bottle blank).

- **Equipment Rinsate Blanks.** Equipment rinsates are samples of distilled/deionized water passed through decontaminated sampling equipment before use of the equipment. Rinsates are used as a measure of the effectiveness of the equipment decontamination process. Equipment rinsates should be collected in the field and at the rate specified in the sampling document. An equipment rinsate should be collected from each type of sampling equipment used to ensure that the decontamination procedures are applicable to all equipment types.

  Equipment rinsates are analyzed for the same analytes as samples collected using that equipment. All sample results should be evaluated to determine the possible effects of any contamination detected in the equipment rinsate blank.

- **Collocated Duplicate Samples.** Collocated duplicate samples are independent samples collected as close as possible to the same point in space and time and are intended to be identical. Collocated duplicate samples provide information regarding the homogeneity of the matrix, and may also provide an evaluation of the precision of the analysis process. A typical sampling frequency for collocated duplicate samples is approximately 1 for every 20 regular samples, or one per borehole. Collocated soil cores collected for volatile organic analysis should be sealed immediately and shipped to the laboratory. Collocated sample data are to be reviewed in the same manner as duplicate sample data.

A3.5.1.2 Field QC Samples for Laboratory Evaluation.

- **Field Splits.** Field split samples are two uniquely numbered samples produced through homogenizing a field sample and separating the sample material into two separate aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for the purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. Collection and analysis of field split samples is generally not performed, as there are formal check procedures that are used to evaluate interlaboratory accuracy and precision.

- **Field Blanks.** Field blanks are samples of analyte-free media similar to the sample matrix transferred from one vessel to another at the sampling site. This blank is preserved and processed in the same manner as the associated samples and is used to document contamination in the sampling and analysis process (e.g., ambient volatile organic chemicals from operating machinery).

A3.5.2 Onsite Measurements Quality Control

Requirements for QC samples prepared and analyzed for onsite measurements (field screening) include blanks, background samples, duplicates, and standards. Further details regarding these samples can be found in BHI-EE-05, Procedure 1.0, "Routine Field Screening," and in Volume 3 of the HASQARD (DOE-RL 1998). The specific type(s) of QC sample(s) and frequency of collection will vary with the field analytical method, and will be specified in the waste group-specific sampling document.

- **Blanks.** A blank is defined as data acquisition without an actual sample, used to establish an instrument baseline. A minimum of one blank is typically collected per day or shift.

- **Background Samples.** Background samples are used to measure a matrix-specific baseline. If background samples are needed, a minimum of two shall be collected and analyzed at a site.

- **Duplicates.** Duplicates are typically used as an indication of precision associated with the analytical process by calculating the relative percent difference between two results. At least one duplicate per field analytical method for each day of testing is recommended.

- **Matrix Spikes.** A matrix spike is a field sample to which a compound with a known concentration is added. This sample is then carried through the entire analytical process to evaluate the interferences of other constituents in the field sample. Matrix spikes may not be practical where field preparation cannot be accomplished, the compounds involved are too hazardous to handle in the field, or where there is another method to determine proper functioning of the instrument or test kit.

- **Standards.** A standard is a sample with a known concentration, used to determine the accuracy of the instrument. The use of standards varies with the specific field instrument.

A3.5.3 Laboratory Quality Control

Method and/or protocol specific QC requirements shall be followed as outlined in the laboratory procedures or laboratory statement of work. Laboratory QC samples must be run as part of the delivery group or analytical batch as applicable. Types of laboratory QC samples are discussed below. Typical requirements for laboratory QC frequency and levels are provided; specific analytical techniques or protocols may have different requirements.

- **Laboratory Control Samples.** Laboratory control samples (LCSs) contain known quantities of analytes and are carried through the sample analysis procedure. Recovery (determined as the percentage of "found" analyte relative to the known amount introduced) is used to assess the accuracy (bias) of the analytical technique.

As much as possible, LCSs shall be of a similar matrix and contain the same constituents of interest as the samples. Reference materials used to produce (e.g., spike) the LCS must be traceable to National Institute of Standards and Technology (NIST) (or equivalent) if possible and be of known quality. The LCS concentrations shall be at least 5 but not greater than 20 times the applicable required detection limits (RDLs). The LCSs shall be run at a minimum frequency of 1 in 20 samples, once per analytical batch, or once per delivery group, whichever is most frequent. LCS samples shall be prepared and analyzed in the same manner and have the same detection limit objectives as the samples.

- **Replicate Analyses.** Replicate analyses consist of reanalysis of a sample, typically starting with the "raw" sample material. Replicate analyses are used to assess precision of the analysis. Some analytical techniques assess analytical precision via replicate measurement of "spiked" sample materials (see matrix spike).

  Replicate analyses shall be run at a minimum frequency of 1 in 20 samples, once per analytical batch, or once per delivery group, whichever is most frequent. Replicate samples shall be prepared and analyzed in the same manner as the samples and have the same detection limit objectives. If sufficient sample material has been provided, replicate samples shall use the same aliquot size as the original sample. It may be advantageous to request that the laboratory replicate a specific sample within a group of samples. This would typically be requested for the sample judged to have the highest concentrations of contaminants, to minimize the possibility of replicating a sample that has contaminant levels below the detection limit; this approach would provide the maximum amount of information from the replicate.

- **Preparation Blanks.** Preparation banks are materials known to be free from contamination that are carried through the same analytical procedure as the samples. Preparation blanks are used to evaluate potential laboratory contamination of samples that could result in reporting of false positive results.

  Preparation blanks shall be run at a minimum frequency of 1 in 20 samples, once per analytical batch, or once per delivery group, whichever is most frequent. Preparation blanks shall be prepared and analyzed in the same manner and meet the same detection limit objectives as the samples.

- **Matrix Spikes/Matrix Spike Duplicates.** Matrix spikes consist of analysis of a replicate of an actual sample to which a known quantity of the analyte has been added. Recovery (determined as the percentage of "found" analyte relative to the known amount introduced) provides information on sample specific matrix effects that result in an analytical bias for a given analysis batch. Matrix spike duplicates are an additional matrix spike sample required by some analyses where analysis of a simple replicate sample is inappropriate.

  The spiking materials must be traceable (NIST, if possible) and of known quality. If possible, spikes shall be the same component as the samples. The matrix spike should be added at a concentration of at least 5 but not greater than 20 times the applicable RDL. Matrix spikes shall be prepared and analyzed at a minimum frequency of one per analytical batch, delivery group, or 20 samples of like matrix, whichever is most frequent. The matrix spike shall be prepared and analyzed in the same manner and have the same detection requirements as the client samples.

Matrix spikes are not required for radiochemical analyses if an isotopic tracer or chemical carrier is used in the analysis to determine chemical recovery (yield) for the chemical separation and sample mounting procedures. Matrix spikes shall be run on a separate sample aliquot using the same element as that being analyzed whenever possible. Matrix spikes are not required for gross alpha, gross beta, or gamma energy analysis.

A3.6 INSTRUMENT CALIBRATION AND MAINTENANCE

Onsite measurement test instruments shall be calibrated and maintained in accordance BHI-QA-03, Procedure 5.2, "Onsite Measurements Quality Assurance Program Plan," Procedure 5.3, "Radiological Measurements and Environmental Support Quality Assurance Program Plan," and the manufacturer test instructions. These procedures address calibration, standards, test equipment, onsite measurement procedures, data collection, reduction, and reporting.

The results from all instrument calibration and maintenance activities shall be recorded in a bound logbook in accordance with procedures outlined in BHI-EE-01, Procedure 1.5, "Field Logbooks" (described in Section A2.6). Contract laboratory instruments shall be calibrated and maintained in accordance with the requirements specified by the applicable purchase requisition.

A3.7 FIELD DOCUMENTATION

Field documentation shall be managed as specified in Section A.2.4.

A3.8 DATA MANAGEMENT

Data resulting from the implementation of this QAPjP shall be managed and stored by the ERC organization responsible for sampling and characterization, in accordance with BHI-EE-01, Section 2.0, "Sample Management." At the direction of the task lead, all analytical data packages shall be subject to final technical review by qualified personnel before their submittal to regulatory agencies or inclusion in reports. Electronic data access, when appropriate, shall be via a database (e.g., Hanford Environmental Information System or a project-specific database). Where electronic data are not available, hard copies shall be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994).

A4.0 ASSESSMENT/OVERSIGHT

The Compliance and Quality Programs group may conduct random surveillance and assessments in accordance with BHI-MA-02, *ERC Project Procedures*, Procedure 2.9, "Surveillances," to verify compliance with the requirements outlined in this appendix, project work packages, the BHI Quality Management Plan, and BHI procedures and regulatory requirements. These surveillances may include review of plans, procedures, and records containing results of inspections and tests for completeness, adequacy, and compliance with requirements; witnessing activities/operations in-process to verify accomplishment of required tasks; review of administrative records such as training records and process certification records; review of other types of documents such as field logbooks, calibration records, configuration control logs, records of previous accomplishment of corrective actions, and permits; personnel interviews; and physical walk-downs of operations or sites for compliance to specified requirements.

Deficiencies identified by assessments shall be reported in accordance with BHI-MA-02, Procedure 2.7, "Self-Assessments." This procedure describes the tracking and reporting of self-assessments, and recommends that the report contain the purpose of the assessment, the activity or area assessed, applicable requirements/criteria used as the basis of the self-assessment, a description of how the self-assessment was performed, actions taken or recommended and assigned personnel responsible for open actions, and the various signatures required on the report.

When appropriate, corrective actions shall be taken by the task lead in accordance with the HASQARD, Volume 1, Section 4.0 (DOE–RL 1998) to minimize recurrence.

A5.0 DATA VALIDATION AND USABILITY

Sample data shall be reviewed to ensure that analyses were performed and reported as requested. Sample results that require validation shall be validated in accordance with the requirements specified by BHI-EE-01, Procedure 2.5, "Data Package Validation Process." A variety of validation levels are available through the referenced procedure to meet the specific project needs. Specific validation requirements for each waste site grouping, including the validation frequency and level, should be developed through the DQO process and shall be defined in appropriate group-specific sampling plans.

The data validation process will qualify analytically questionable data, but the reason for the qualifiers may be further considered and evaluated. For example, if an analysis is qualified because it exceeded the holding time called for by the analytical procedure, it may nevertheless be useful data. Careful consideration of the specific chemical, the condition that led to its qualifier, and the end use of the data may allow some data that are initially qualified to be used in support of the sampling objectives.

A6.0 DATA QUALITY ASSESSMENT

The Data Quality Assessment (DQA) process compares the implemented sampling approach and resulting analytical data against the sampling and data quality requirements specified by the DQOs. Most of the elements of this process are applicable only to data collected by a random sampling design, and thus will typically be applicable only to verification data. Step 2 of the process (below), dealing with

QA/QC of the samples, can be applied to all data types. The results of this process determine whether the data are of adequate quality and quantity to support the decision-making process.

There are five steps to the DQA process. These are presented and summarized below.

Step 1. Review DQOs and Sampling Design. This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO workbook and SAP.

Step 2. Conduct a Preliminary Data Review. In this step, a comparison is made between the actual QA/QC achieved (e.g., detection limits, precision, accuracy, completeness) and the requirements determined during the DQO. Any significant deviations should be documented. Basic statistics should be calculated from the analytical data at this point, including an evaluation of the distribution of the data.

Step 3. Select the Statistical Test. Using the data evaluated in Step 2, select an appropriate statistical hypothesis test and justify the selection of this test.

Step 4. Verify the Assumptions. This step, which is optional, assesses the validity of the statistical hypothesis test by determining if the data support the underlying assumptions necessary for the selected test or if the data set must be modified (e.g., transposed, augmented with additional data) before further statistical analysis. If one or more assumptions are questioned, return to Step 3 and reevaluate the statistical test selected.

Step 5. Draw Conclusions from the Data. The statistical test is applied in this step, and the results either reject the null hypothesis or fail to reject the null hypothesis. If the latter is true, the data should be analyzed further. If the null hypothesis is rejected, the overall performance of the sampling design should be evaluated by performing a statistical power calculation in order to assess the adequacy of the sampling design.

A7.0 REFERENCES

10 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*, as amended.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-05, *Field Screening Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-10, *Waste Management Plan*, Bechtel Hanford, Inc., Richland, Washington.

BHI-HR-02, *ERC Training* Procedures, Bechtel Hanford, Inc., Richland, Washington.

BHI-MA-02, *ERC Project Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-03, *ERC Quality Assurance Program Plans*, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998, *Remedial Action and Waste Disposal Project Manager's Implementing Instructions*, BHI-00901, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

DOE Order 5700.6C, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1995, *Hanford Sitewide Background, Part 1: Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Hanford Analytical Services Quality Assurance Requirements Documents*, DOE/RL-96-68, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA, 1994, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, QA/R-5, U.S. Environmental Protection Agency, Quality Assurance Division, Washington, D.C.

EPA, 1986, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846, 3rd ed., Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended.

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

Task/Method	Description	Uses/Benefits	Problems/ Limitations	Value to Characterization at Stage of Application				
				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)
Historical Investigation	- Photographic Imagery (ground and air) - Airborne Gamma Surveys - Stereo Photography - WIDS database	- Document waste site locations and ground surface conditions. - Document site changes over time. - Quickly identify contaminated areas.	– Photo and aerial survey coverage is incomplete and inconsistent over history of Hanford operations. – Photo record is extensive but not well maintained, indexed or readily available.	High	Low	Low	Low	Low
Surface Radiological Surveys	- Analyze radiological activity of surface soils with hand-held instruments or mobile surface contamination monitor.	- Qualitative/ semiquantitative determination of presence/absence of radionuclides (total gamma, beta, and alpha). - Standard, cost-effective method. - Direct and noninvasive. - Applicable to large areas	– Generally not capable of radioisotopic analysis. – Generally not quantitative.	Medium	Low	Low	Medium	Medium
Surface Soil Sampling	- Collect soil samples for field or laboratory analysis.	- Rapid and inexpensive collection of soil using simple tools and techniques. - More detail provided in Table A-3.	– Limited to near-surface. – Sample only represents small portion of waste site.	Medium	Low	Low	High	Low

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

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				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)
Test Pits/ Trenching	- Soil excavation at waste sites to permit sampling of shallow contamination.	- Relatively easy and quick method to examine subsurface geology and collect samples in the first 8 m (25 ft) of soil column. - Standard, cost-effective method - "Unlimited" available sample volume.	– Care required to ensure that sidewall sloughing does not cross contaminate soil sample. – Depth limited by size of available backhoe. – May be difficult to collect samples from narrow discrete intervals. – Disturbed sample limits physical properties tests that can be performed.	N/A[1]	High	High	Medium	Low
Boreholes	- Driven, cable tool, sonic push or air rotary drilling methods to recover soil samples and/or deploy geophysical tools.	- Can provide continuous or interval samples/record of soil column stratigraphy through observation of cuttings and/or split spoon samples. - Standard method available on site. - "Unlimited" depth potential. - Useful in all types of geologic media. - More detail provided in Table A-3.	– Expensive and time consuming process. – Potentially non-representative samples for physical properties. – Sample only represents small portion of waste site. – Sample recovery and volume limited based on lithology.	N/A[1]	High	High	Medium	High

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

Task/Method	Description	Uses/Benefits	Problems/ Limitations	Value to Characterization at Stage of Application				
				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)
Borehole Geophysical Logging	- Remote analysis of soil column around borehole or cone penetrometer with passive and active tools to evaluate soil moisture, porosity, gamma-emitting radionuclides, etc.	- Readily available on site; cost-effective for the amount of data collected. - Several different tools are available for soil property characterization. - Continuous logs can evaluate a substantial vertical profile. - Data are accurate, near real-time. - Spectral gamma analysis available (cone penetrometer)	– Borehole diameter and construction data is critical to use and interpretation of data. – Significant interpretation and calibration required to assure meaningful results.	High, (using existing boreholes)	High (using new boreholes)	High	Low	High
Cone Penetrometer	- Pushed or driven hollow rods used to provide access to subsurface.	- Rod driving forces can be used to detect lithology changes. - Cost effective compared to boreholes. - Rods can be equipped for a number of sampling and characterization purposes, including geophysical logging. - Relatively rapid borehole construction. - Good for soil gas surveys. - Developing technologies for tomographic subsurface imaging, in situ x-ray fluorescence.	– Some limitation on depth of characterization, based on lithology and size of equipment. – Collection of soil samples very limited; typically poor recovery.	N/A[f]	High	High	Medium	Low

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

Task/Method	Description	Uses/Benefits	Problems/ Limitations	Value to Characterization at Stage of Application				
				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)
GeoProbe	- Pushed and vibrated hollow rods of small diameter, used to provide access to subsurface	- Rapid and cost-effective. - Available on site. - Excellent for soil gas surveys. - Can be used with some specially configured geophysical tools, several currently in development.	– Severe limitation on depth, due to small rod size and driving unit. – Collection of soil samples depth limited; recovery is poor in some lithologies.					
Field Analysis	- In field chemical analysis of soil samples. Portable or mobile lab/truck mounted field tests and equipment.	- Wide variety of tests and instrumentation available. - Relatively cost-effective compared to fixed laboratory analysis. - Quick turnaround for results is possible. - Available for volatile organics, semi-volatile organics, pesticides, herbicides, metals, PCBs, etc. -	– Analytical accuracy and precision generally poor compared to fixed laboratory analysis. – Results are not suitable for most regulatory decision-making (unless routine laboratory confirmation is specified). – Generates waste that must be dispositioned.	N/A[1]	Medium	Medium	High	Low
Laboratory Analysis	- Routine, high quality chemical and radiological analysis of soil samples using instrumentation and techniques that produce data of high precision and accuracy.	- Laboratory analysis is the standard for highest quality, lowest detection level results, for virtually any target analyte. - Standard for regulatory decision-making. - Use is assumed to occur with borehole, test pit, soil gas, or surface sampling activities.	– Expensive and not timely. – Rigorous sampling requirements necessary to insure representative results.	N/A	High	High	Medium	Low

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

Task/Method	Description	Uses/Benefits	Problems/ Limitations	Value to Characterization at Stage of Application				
				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)
Surface Geophysical Methods	- Use of surface instrumentation to remotely evaluate the subsurface. Methods include Ground Penetrating Radar (GPR), Electromagnetic Induction (EMI) and Magnetic techniques/ instrumentation to measure response to signals.	- Evaluation of shallow subsurface to define boundaries of an excavation, and detect buried manmade materials such as drums, pipelines, etc. - Provides rapid, broad areal coverage. - Cost effective, readily available, near real-time data. - Works best where significant contrast in material property response exists (e.g., metal vs. soil).	– Generally limited to depths <6 m. – Considerable interpretation of results may be necessary.	High	High	Low	Low	Low
Multi-Bore hole Geo-physical Techniques	– Crosshole geophysical measurements using electrical resistance, nuclear-magnetic resonance, and x-ray computed tomography tools/techniques.	- Techniques are currently regarded as most useful in measuring soil moisture changes. - Proposed as a method of monitoring for leak detection around tanks. - Excellent areal and vertical coverage possible.	– All systems are in preliminary stages of development and are very expensive to procure. – Multiple boreholes required. – Extensive computer modeling required to produce results.	Low	Low	Low	Low	High
Surface Geophysical Methods (for Soil Moisture Content)	- Similar techniques to routine (GPR, EMI) methods, plus Electrical Resistivity. - Instrumentation modifications and analysis is geared to examining greater depths in the soil column.	- Greater depth penetration due to electrode spacing or antenna configuration. - Used to evaluate relative moisture content differences, organic concentration in subsurface.	– Qualitative rather than quantitative results. – Specific limits and soil interferences for individual techniques. – Limited to top 5 m of soil column, decreased resolution with depth.	Low	Low	Low	Low	High

Table A-1. Potential Tasks and Investigation Methods for Soil Characterization that may be Employed in the 200 Areas (6 Pages).

Task/Method	Description	Uses/Benefits	Problems/ Limitations	Value to Characterization at Stage of Application				
				Pre-Characterization Site Evaluation[a]	Characterization @ Representative Sites[b]	Confirmation Sampling at All Sites[c]	Verify Remedial Design/ Remedial Action[d]	Post-Closure Monitoring[e] (Long Term)

Notes:

[a] Pre-Characterization is used to indicate simple, inexpensive, non-invasive activities that can be conducted around a waste site without an expectation of generating data suitable for site characterization. The work may be performed by ERC or by others.

[b] Characterization at Representative Sites addresses Work Plan directed activities which follow the Implementation Plan strategy. It is assumed that some invasive drilling/trenching activities will be performed to acquire samples in support of refining a conceptual model and determining a suitable remediation strategy for all waste sites in a waste group.

[c] Confirmation sampling at All Sites is a typically invasive examination of all waste sites in a group to determine that a selected remedy is appropriate for all sites and that each waste site is appropriately placed in that group. The characterization event also serves to determine the extent of the boundaries for each site for a given remedial measure.

[d] Verify Remedial Design/Remedial Action sampling is appropriate for designs/plans at sites/groups primarily to be treated by a remove, treat and dispose remediation option for contaminated soil. Here the limits of excavation and disposal are dictated by contaminant concentrations. Sites receiving covers would not necessarily require verification sampling.

[e] Post-Closure Monitoring is a long-term examination of remediated waste sites, primarily with respect to the movement of contaminants and moisture through the vadose zone. Requirements for this would be specified in the Closure/Post-Closure Plan. The primary concern is the movement of moisture through the soil column transporting contaminants to the groundwater table. Soil-moisture-content based detection systems in boreholes are currently viewed as the best tools for this task.

N/A = Not Applicable. Within stated bounds of Pre-Characterization at Representative Sites, above, these activities are viewed as exclusively characterization-based activities.

Table A-2. Topics to be Considered During a Waste Group-Specific DQO.

Item	Aspect to be Considered
1.	Project assumptions (especially assumptions that could result in project failure).
2.	Identification of the regulatory pathway, phase, and logic.
3.	Identification of regulatory, legal, agreement, and statute obligations and constraints (e.g., *Hanford Federal Facility Agreement and Consent Order* [Tri-Party Agreement] milestones, applicable or relevant and appropriate requirements, waste acceptance criteria requirements).
4.	Development of ERC legal positions or interpretations.
5.	Identification of regulatory quantitative limits (e.g., maximum contaminant levels, Model Toxic Control Act A, B, or C Cleanup Levels).
6.	Identification of National Environmental Policy Act needs and constraints (e.g., clearances, surveys, impact analyses).
7.	Identification of cultural and biological constraints (e.g., clearances, surveys).
8.	Waste management requirements (applicable procedures, waste acceptance criteria, land disposal requirements treatment standards).
9.	Air quality constraints.
10.	Health physics risks, hazards, and as low as reasonably achievable needs (e.g., isotopic profiles).
11.	Milestone requirements (e.g., Tri-Party Agreement, RCRA permit, ERC project schedules).
12.	Availability and summation of all data available, historical information, waste inventories, contaminant analyses and concentration ranges, drilling records, geophysical data, background values, monitoring measurements, ecological reports (e.g., Hanford Environmental Information System [HEIS] data, data files).
13.	Evaluation and summary of process knowledge (e.g., historical baselines).
14.	Identification of potential data uses and users (e.g., data analysis plans, models, Waste Information Data System, HEIS, decision makers, public).
15.	List of contaminants of concern (e.g., process knowledge, Records of Decision lists, limited field investigation/qualitative risk assessment reports, RCRA Part A Permit Application).
16.	List of potential investigation method alternatives.
17.	List of potential remedial design criteria and alternative data needs.
18.	Maps and diagrams.
19.	Cost-estimating tools and documents.
20.	List of analytical methods and detection limits (e.g., *Test Methods for Evaluating Solid Waste* [SW-846], toxic characteristic leaching procedure, field screen).
21.	Risk assessment models, pathways, receptors, parameters, and fate and transport parameters.
22.	Radiation detection methods and detection limits.
23.	List of proposed agreements to be achieved (e.g., issues to be resolved).

Table A-3. Soil Sampling Techniques Likely to be Employed in the 200 Areas.

Sampling Methods	Sampling Techniques	Advantages/ Disadvantages	Limitations
Test pits/trenching	Scoop, directly from pit/trench or backhoe bucket	Easy to use in unconsolidated soils; fast and cost-effective. Good quality samples can be collected, but may not be as representative as split-spoon samples	Manned entry into unsupported excavation limited to 1.5 m depth; effective depth of sampling from backhoe bucket is approximately 6 m.
Shallow surface sampling	Scoop/Spade/ Shovel	Simple and effective in unconsolidated materials, recovery is generally good. Must use disposable tools or decontaminate between samples.	Effective depth of sampling is typically <15 cm. Difficult to sample consolidated materials.
	Hand Auger	Simple in unconsolidated soils; portable. Cross-contamination is likely and collection of undisturbed sample is infeasible.	Effective for top 3 m of soil. May locally homogenize sample. Not recommended for volatile organic analytes, because augering motion facilitates volatilization.
	Hand Corer/Sediment Punch	Useful in many soil types. Sample recovery difficult with small diameter core tube.	Not effective below approximately 60 cm. Difficult to sample consolidated materials.
	Split tube	May be used in conjunction with pits/trenches to obtain deeper samples. Requires heavy equipment (drill rig, backhoe) to drive tube.	Not effective below approximately 1 m.
Deep Soil Sampling	Cone Penetrometer/ GeoProbe	Relatively fast and inexpensive in unconsolidated formations; excellent contamination control. Rod driving forces may be used to detect lithology changes.	Depth is limited to approximately 30 m in unconsolidated materials. Only small sample volume can be obtained; limited to one sample per hole.
	Auger Drilling	Potentially fast and inexpensive. Hollow flights can be used in conjunction with a split spoon to obtain representative samples. Cross-contamination is a potential problem.	Not practical for obtaining very deep samples. Relatively large volume of cuttings may create waste disposal problem.
	Cable Tool Drilling	Excellent contamination control and high-quality sample collection. Can be used under most environmental conditions.	Relatively slow and expensive.
	Sonic Drilling	Fast and relatively inexpensive. Heat generated may alter chemical and physical properties of sample.	Sample quality is often poor. Collection of meaningful volatile organic analyte sample is difficult.
	Air Rotary Drilling	Fast, depending on sampling requirements. Quality samples can be collected.	Use in contaminated areas may create an air release issue.

APPENDIX B

GENERAL HEALTH AND SAFETY PLAN

B1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

B1.1 INTRODUCTION

The purpose of this appendix is to outline standard health and safety requirements for Bechtel Hanford, Inc. (BHI) employees and contractors engaged in remedial investigation activities in the 200 Areas waste groups. These activities will include surface investigation, drilling groundwater wells, groundwater sampling, characterization boreholes and test pits, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., site-specific health and safety plan [SS HASP], activity hazard analysis [AHA]) will be written for each task or group of tasks. Specific safety procedures are documented in the BHI *Safety and Health Procedure Manuals* (BHI-SH-01 and BHI-SH-02). The *Radiological Control Work Instructions* manual (BHI-SH-04) and the *Hanford Site Radiological Control Manual* (HSRCM) (HSRCM-1) provide specific procedures relative to radiological concerns.

All employees of BHI or any other contractors who are participating in onsite remedial investigations activities in the 200 Areas waste groups shall read the site-specific safety documentation and attend pre-job safety or tailgate meetings to review and understand any hazards associated with the work scope.

B1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management. Their names will be properly recorded before the task is initiated. All onsite activities must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, SS HASP or AHA, sampling plan, and radiological work permits [RWP])
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the SS HASP or AHA
- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the SS HASP at the site. The site safety officer shall do the following:

- Monitor chemical, physical, and (in conjunction with the radiological control technician [RCT]) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the Radiological Control organization.
- Monitor the performance of all personnel to ensure that the required safety procedures are followed.
- Halt operations immediately, if necessary, due to safety or health concerns.
- Conduct safety briefings, as necessary.
- Assist the field team leader in conducting safety briefings, as necessary.

The field team leader is responsible for site safety and health. The field team leader will use the Environmental Restoration Contractor (ERC) Radiological Control organization for ensuring that all radiological monitoring and protection procedures are being followed as specified in the HSRCM (HSRCM-1) and in the appropriate RWP. BHI Safety and Health personnel will provide safety overview during work site activities consistent with U.S. Department of Energy (DOE) and BHI policy and will provide technical advice, as requested. Personnel monitoring and downwind air monitoring for hazardous materials and radiological or other contaminants may be requested from appropriate project or contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee has "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and RCT will determine the next course of action.

B1.3 MEDICAL SURVEILLANCE

All field team members engaged in hazardous waste site activities at sites governed by a SS HASP must have baseline physical examinations and participate in the BHI (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using personal protection equipment including level B. This would include any condition that increases the employee's susceptibility to heat stress.

B1.4 TRAINING

As described in BHI-SH-02, Volume 1, all employees entering the work site must have the necessary qualifications and training to perform the assigned task in a safe manner. Prior to performing work on the site, each employee will attend training as specified in the Work Site Safety and Health Orientation. The initial training includes Hanford Site Orientation and/or Hanford General Employee Training. The topics covered in these training sessions include company and employee rights and responsibilities, alcohol and drug abuse policies, accident and incident reporting, emergency warning systems, and basic fire protection. Performing tasks in a radiation area or an exclusion zone will require the employee to have completed a variety of training requirements as described in the RWP and the SS HASP.

Each member of the team involved in a hazardous waste site operation is required by *Code of Federal Regulations* (CFR) 1910.120 to have received 40 hours of specific hazardous waste site training (and annual 8-hour refresher course). The field team leader and the site safety officer will also have an additional 8 hours of special training related to the operation of a hazardous waste site. Employees not directly involved with hazardous waste handling will have a minimum of 24 hours of training and be supervised by the field team leader.

B1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site, who is not a Hanford Site contractor employee directly involved in the *Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act* facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must enter a controlled (either contamination reduction or exclusion) zone are subject to all of the applicable training, respirator fit testing, and medical surveillance requirements previously discussed. Escorts will inform all visitors of potential hazards and emergency procedures.

B1.6 CONTINGENCY AND EMERGENCY RESPONSE PLANS

In the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a pre-designated safe area as specified in the site-specific safety documentation. The SS HASP will designate specific emergency response procedures for reasonably anticipated site-specific emergency situations/scenarios.

B1.7 RADIATION DOSIMETRY

All personnel engaged in onsite activities will be assigned dosimeters according to the requirements applicable to the activity. All visitors will be assigned dosimeters if required.

B1.8 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of BHI and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Before using a negative pressure respirator, each employee must have been fit-tested (within the previous year) for the specific make, model, and size according to fit-testing procedures in use by the ERC through the Hanford Environmental Health Foundation. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to BHI that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

B1.9 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

Appropriate respiratory protection will be required when conditions are such that the airborne radiological contamination levels may exceed administrative control levels for respiratory protection. Such conditions may result because of the presence of high levels of uncontained, loose contamination on exposed surfaces or from operations that may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation or drilling under extremely dry conditions.

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgement of the RCT, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

B2.0 GENERAL PROCEDURES

A hazardous waste site presents numerous health and safety concerns. The following guidelines represent the minimum requirements for reducing potential risks associated with 200 Areas waste group work scope activities.

B2.1 GENERAL WORK SAFETY PRACTICES

B2.1.1 Work Practices

The following work practices must be observed.

- Eating, drinking, smoking, taking medications, chewing gum, and similar actions are prohibited within the exclusion zone. Allowances for water may be authorized by the RWP during heat stress conditions. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.

- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting. Mechanical lifting devices are to be used in lieu of manual lifting even with the buddy system for excessively heavy items.

- Radiological Control procedures will be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall be carried out only during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the SS HASP, AHA, or RWP.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.

- Do not enter any test pit or trench deeper than 1.2 m (4 ft) unless in accordance with procedures specified in the SS HASP.

- Do not <u>under any circumstances</u> enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific hazardous work permit as addressed in the SS HASP, including cutting and welding, confined space entry, and excavation.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. <u>Never</u> allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials. Vehicles should be equipped with a fire extinguisher.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

B2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the SS HASP. The site safety officer in conjunction with BHI Radiological Control and Quality, Safety, and Health organization will choose the appropriate type and level of protection required for different activities at the job site.

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The SS HASP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, RCT, and site safety officer.

- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the SS HASP or AHA.

- The exclusion zone around noisy drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.

- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act, or standards for working over water will be available and used when applicable.

B2.1.3 Personal Decontamination

- The SS HASP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- At the end of each workday or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes, or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the RCT, site safety officer, or field team leader.

B2.1.4 Emergency Preparation

- A certified first aid provider and equipment shall be at all construction sites and work locations where emergency medical service is longer than 3 minutes away.

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.

- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan and potential hazardous and radioactive materials that may be present and handled. A site location map shall be included in this notification.

B2.1.5 Confined Space/Test Pit Entry

- The field investigation activities in the 200 waste group project, as a rule, should not require confined space entry. However, the hazards associated with confined spaces are of such severity that all employees should be aware of safe work practices related to such conditions. Requirements for confined space entry will be included in the job-specific AHA or SS HASP where confined space entry is required.

- Before entering any confined space, including any test pit, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors, may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry. All "permit required confined spaces" as defined by OSHA in 29 CFR 1910.146 require, at a minimum, continuous ventilation prior to and during entry. In every case, specific entry procedures shall be set forth in the SS HASP.

- No employee shall enter any test pit or trench deeper than 1.2 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations. If an employee is required to enter a pit or trench 1.2 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

B3.0 POTENTIAL HAZARDS

While the information presented in Section 3.1 of the 200 Areas Implementation Plan is believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. Onsite tasks will involve noninvasive surface sampling procedures and invasive techniques. Hanford Site waste sites have the potential to contain hazardous chemical substances, toxic metals, and radioactive materials.

Nonintrusive investigative techniques, such as surface radiological surveillance, surface sampling, geophysical surveys, and mapping activities have a potential concern of fugitive dust and radiological contamination. Invasive investigative techniques could encounter hazardous substances that may include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as solvent storage buildings or underground storage tanks and piping.

Potential hazards include the following:

- External radiation (beta-gamma) from radioactive materials in the soil
- Internal radiation resulting from ingestion, inhalation, or absorption through open cuts and scratches
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals
- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, pinch points, overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Penetrating unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

The general safe work practices previously described were designed to reduce as many hazardous situations as possible.

B4.0 SITE CONTROL

The field team leader, site safety officer, and RCT are responsible for coordinating access control and security at the work site. Special control measures may be necessary to restrict public access. If the
controlled zone is also a radiological area, all members of the team must also heed the criteria of the RWP.

Controlled areas will be clearly marked with rope and/or appropriate signs. Controlled zone boundary size and shape may increase or decrease based on field monitoring results, climatic changes, or revisions in operational technique. The site command post and staging area will be established upwind of the control zone, as determined by an onsite windsock. Vehicle access and accessibility to utilities and sampling locations may also be a consideration in the location of the command post.

B5.0 REFERENCES

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations*, as amended.

ACGIH, *Threshold Limit Values and Biological Exposure Indices*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

BHI-SH-01, *ERC Environmental Safety and Health Program*, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-02, *Safety and Health Procedures*, Volumes 1-4, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-04, *Radiological Control Work Instructions*, Bechtel Hanford, Inc., Richland, Washington.

HSRCM-1, *Hanford Site Radiological Control Manual*, HSRCM-1, Revision 2, Richland, Washington.

NIOSH, 1994, *Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Washington, D.C.